WIN! 10 RASPBERRY PI 3 & CASES SIGNED BY EBEN

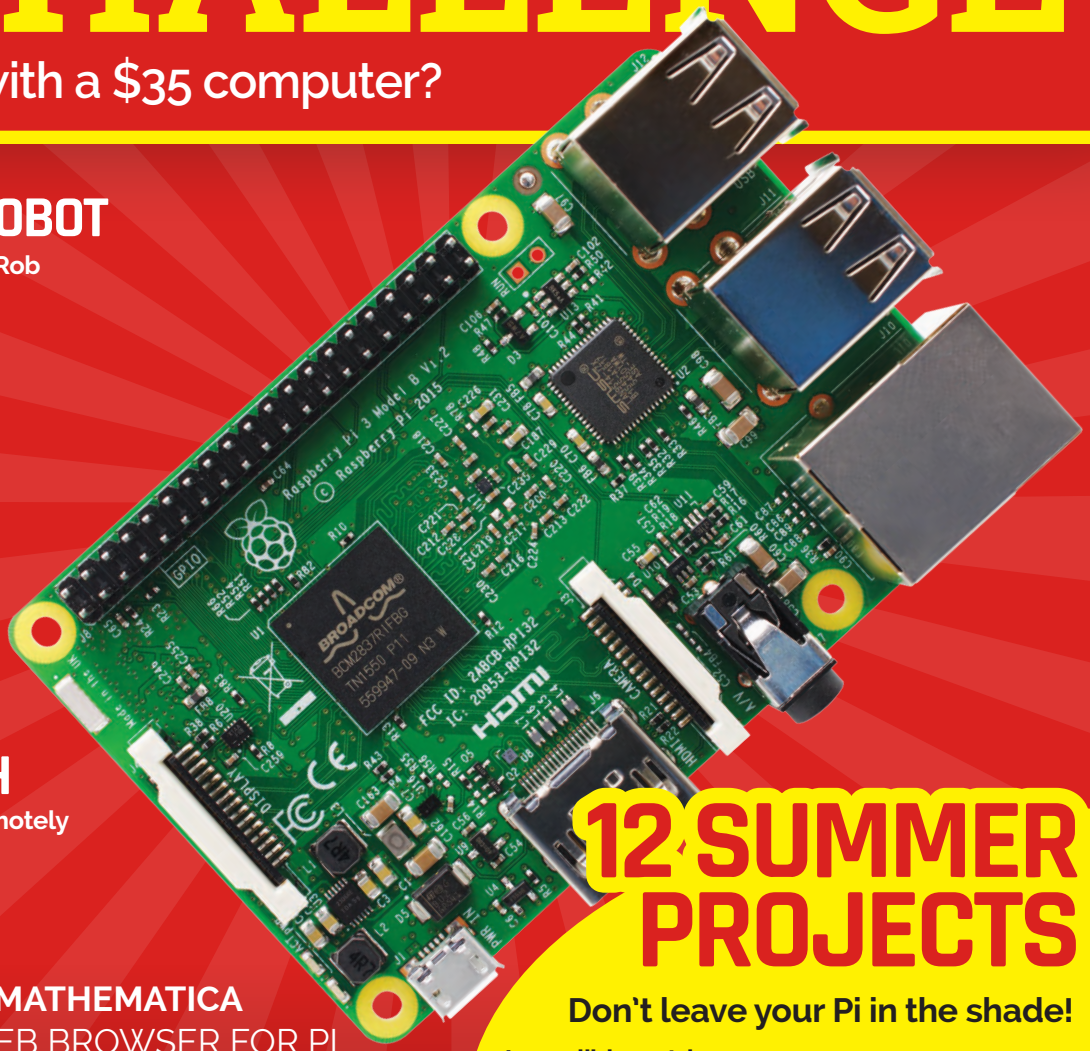
The MagPi

The official Raspberry Pi magazine

Issue 59 July 2017 raspberrypi.org/magpi

THE RASPBERRY PI PC CHALLENGE

What can't you do with a $35 computer?



CREATE A SATNAV ROBOT

Discover precision robotics with Big Rob

DESIGN A DOG TREAT DISPENSER

Keep Scooby in snacks with this clever pet project

BUILD A GPS TRACKING DEVICE

The ultimate movement tracker for land and sea adventures

MASTER BLUETOOTH

Take control of your Raspberry Pi remotely

12 SUMMER PROJECTS

Don't leave your Pi in the shade!

Incredible outdoor digital projects for open-air fun

Also inside:

- USE A SENSE HAT WITH MATHEMATICA
- REVIEWED! THE BEST WEB BROWSER FOR PI
- CREATE ELECTRONIC SENSOR WIND CHIMES
- BUILD THE WORLD'S SMALLEST CONSOLE

THE ONLY MONTHLY MAGAZINE WRITTEN BY AND FOR THE PI COMMUNITY

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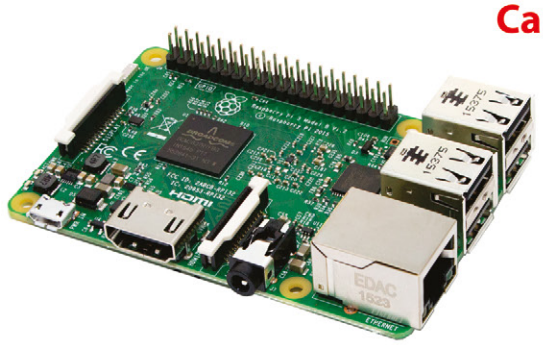

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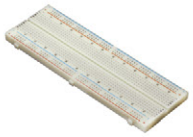

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WELCOME TO THE OFFICIAL MAGAZINE

Many people stare all day at their phone screens, and never think to ask what's going on behind the glass. We want computers we can hack, make, and break (and for it not to matter), and that's exactly why we love the Raspberry Pi. The Raspberry Pi is about GPIO pins and wires, and the Linux OS. It's about making something, and messing up everything, and it not mattering because there's always another chance.

We love it.

But what would it be like to use all the time? Would using a Raspberry Pi every day of the week be digital heaven, or computing hell? That's the task we set our intrepid Features Editor Rob Zwetsloot. Spend a week working with a Raspberry Pi – nothing else allowed. And let us know what it's like: warts and all. You can read all about it on page 16.

The Raspberry Pi is a glorious piece of kit, and it's a shame to keep it in the shade. It is perfectly portable and ideal for aerial balloons, outdoor cameras, weather stations, and all manner of fresh-air projects. We have twelve amazing summer projects for you, starting on page 68.

So whether you're installing a Raspberry Pi permanently in your home, or taking it outside to play, what's important is that you're using the world's most interesting computer. And let us know how you get on.

Lucy Hattersley
Editor - The MagPi

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BUILD A GPS TRACKING DEVICE
MASTER BLUETOOTH
12 SUMMER PROJECTS
FREE PI ZERO W
WITH A SUBSCRIPTION!
PAGE 30
SUBSCRIBE & SAVE 25%
SEE PAGE 30 FOR DETAILS

THIS MONTH:

16 THE RASPBERRY PI PC CHALLENGE
Can you really use a Raspberry Pi as a desktop replacement?

42 GET STARTED WITH GIT
Use Git to clone, copy, and contribute to code

50 BLUE DOT BLUETOOTH
Adding Bluetooth control to your projects has never been easier

68 SUMMER PROJECTS
Twelve incredible outdoor digital projects to make

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Contents

Issue 59 July 2017 raspberrypi.org/magpi

TUTORIALS

> PI 101: SENSE HAT EMULATION **40**
How to create and test code for the Sense HAT

> PI 101: GET STARTED WITH GIT **42**
Manage your code repositories the easy way

> CREATE A GPS TRACKER **48**
Track your travels with this nautical project

> ADD BLUETOOTH CONTROL **50**
Use Blue Dot to control Bluetooth devices

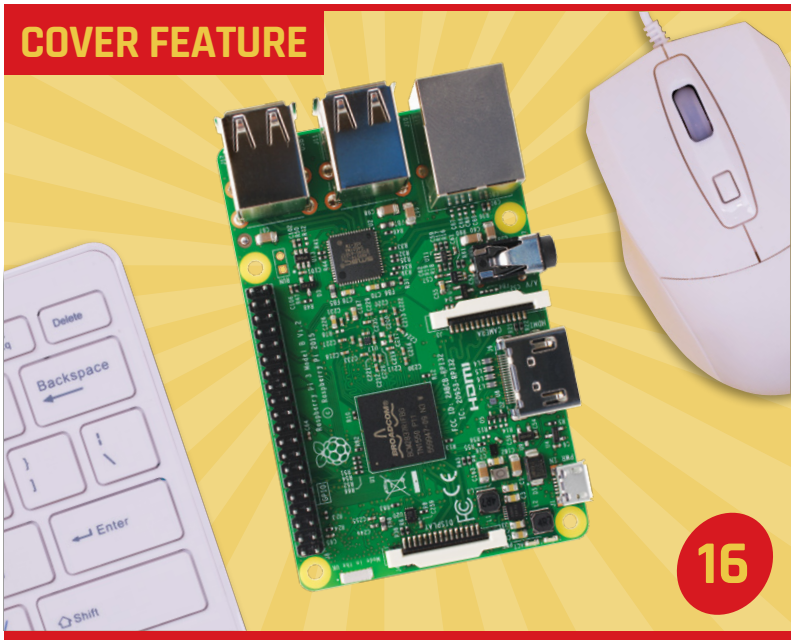
> USE SENSE HAT WITH WOLFRAM **54**
Analyse and display your data with Mathematica

> BUILD WIND CHIMES **56**
This month's Pi Bakery makes wind-powered music

> ADD SERVOS TO AIY PROJECTS **60**
Use the AIY Projects Voice HAT to control servos

> USE MOTORS WITH VOICE HAT **62**
Servos not enough for you? Let's add some motors!

COVER FEATURE



THE PI PC CHALLENGE

IN THE NEWS

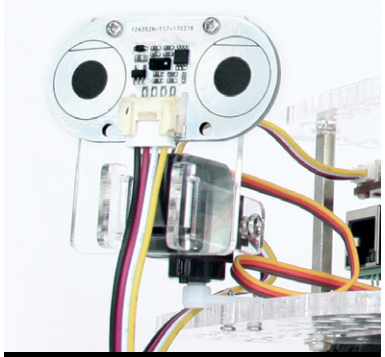
CODERDOJO AND RASPBERRY PI

Two Foundations join forces to bring coding to young people **6**

BEST OF SHOW

Raspberry Pi clusters support medical research **13**

GOPIGO 3



Our friends at Dexter Industries launch a new robot **10**

HOT HOLIDAY PROJECTS 68

Go outside and get making this summer!

BIG ROB ROBOT

Not our Features Editor, but a GPS-controlled robot!

TELE2 VR **34**

Experience the life of a stranger with this incredible Pi project

DOG TREAT DISPENSER **36**

The ultimate, Pi-powered treat dispenser for a very good boy

PIOCKET TINY **38**

The smallest handheld games system we've ever seen

REGULARS

> NEWS **06**

> TECHNICAL FAQ **64**

> BOOK REVIEWS **82**

> FINAL WORD **98**

COMMUNITY

> THIS MONTH IN PI **84**
Everything else that happened last month

> COMMUNITY SPOTLIGHT **88**
Meet awesome YouTuber Estefannie

> EVENTS REPORT **90**
Some of the cool events that took place last month

> UPCOMING EVENTS **92**
Attend one of these upcoming Jams!

> YOUR LETTERS **94**
We endeavour to answer your questions

REVIEWS

> OCTOCAM **76**

> BROWSER GROUP TEST **78**

> WD PIDRIVE USB FLASH **80**

RASPBERRY PI JOINS FORCES WITH CODERDOJO

Teaming up to deliver more for young makers and coders

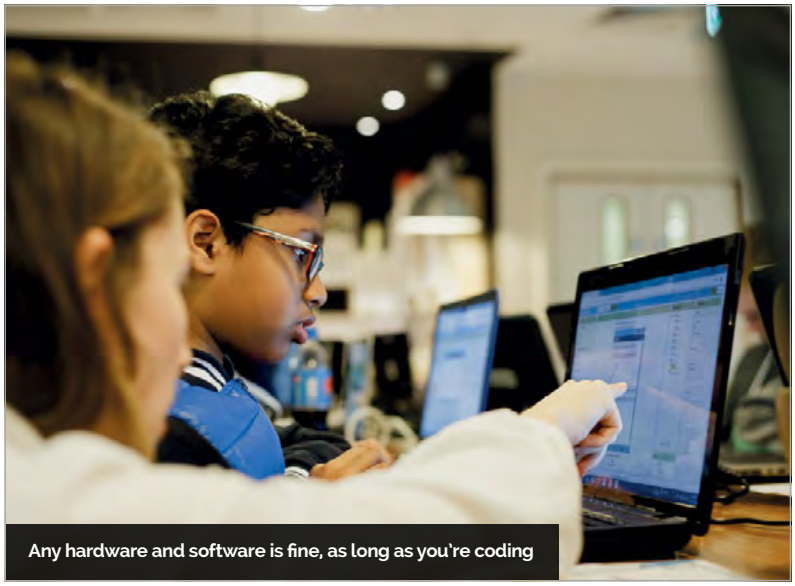
The Raspberry Pi Foundation and the CoderDojo Foundation have merged, with Raspberry Pi Foundation CEO Philip Colligan joining the CoderDojo board. The two Foundations will share back-office resources and expertise to deliver more quickly on their shared goals.

CoderDojo fans won't see any change at the Dojos, however. CoderDojo spokesperson Rosa Langhammer tells us that "CoderDojo is and will always remain 100% content, software and hardware neutral!

"The Raspberry Pi Foundation works to put the power of digital making into the hands of people all over the world," continues Rosa, "and the CoderDojo mission is to give every young person an opportunity to learn and create with technology. By combining our efforts we get closer to these shared goals."

The merger will allow CoderDojo to reach even more young, enthusiastic makers and coders. We'll hear more about these plans in the summer, but Rosa did reveal that part of the strategy review includes "mapping the path to 5,000 Dojos [worldwide] by 2020."

Below Philip Colligan (left), CEO of the Raspberry Pi Foundation, and Giustina Mizzoni (right), Executive Director of the CoderDojo Foundation



Any hardware and software is fine, as long as you're coding

But, "the first priority," Philip tells us, "is to make it as easy as possible to set up and run a CoderDojo. That means investing in the tools and resources that CoderDojo champions and mentors need."

> "We decided we should join forces to accelerate the growth of the CoderDojo movement"

Enabling more people and businesses to set up Dojos won't be easy. That's why the Raspberry Pi Foundation will be "bringing all of the capabilities and expertise of the Raspberry Pi Foundation to support the growth of the CoderDojo movement around the world."

"The CoderDojo Foundation team is really excited," says Rosa, "and is looking forward to working with a wider team of people with similar goals, cooperating on new projects and pooling all our experiences and talents to give more people the opportunity to learn and be creative with technology."

A Dojo in action, with experts and mentors helping kids make and code

WHAT IS CODERDOJO?

Aimed at young people between the ages of 7 and 17, CoderDojos are free, community-led programming clubs for anyone curious about coding. Whether that's building websites, apps, or just figuring out how technology works, Dojos have always offered freedom from hardware and software restrictions – any tool is fine, as long as you're coding.

"The CoderDojo mission is to give every young person an opportunity to learn and create with technology," as spokesperson Rosa Langhammer puts it.

Key to the movement are the volunteer 'Champions' who set up the Dojos. If you or your organisation would like to set up a Dojo, the CoderDojo Foundation will help you get started: visit **magpi.cc/2r4EnVT** for details. You don't need technical skills to start a verified Dojo, just the ability to bring people together, and a passion for the power of code to build a positive future.

To search for a Dojo near you, check the interactive map at **zen.coderdojo.com**.

Perfect timing

Why now? "In a word: demand," Philip explains. "We know that young people all over the world are crying out for places they can go to learn how to get creative with digital technologies. Education systems aren't responding quickly enough to that demand, so we decided that we should join forces to accelerate the growth of the CoderDojo movement."

Both Foundations were established at around the same time, and "we've been working together in lots of ways from the beginning," says Philip. "Lots of the people who are CoderDojo champions and volunteers are also members of the Raspberry Pi community." He also confirms that "we have no plans to change the approach to Code Club or CoderDojo; our priority is encouraging the growth of both initiatives all over the world."

A PI IN EVERY DEVICE?

Eben Upton speaks at the first ever Global Digital Signage Conference

Raspberry Pi co-founder Eben Upton was a key speaker at the recent Global Digital Signage Conference. One attendee had flown in from Brazil just to hear him speak.

> "We took a network that was designed to be resilient to nuclear war and we made it vulnerable to toasters"

Host, and DailyDOOH editor (**dailydooh.com**) Adrian Cotterill, asked about Pi sales. "We're selling about half a million units a month, of the $35 flagship product," replied Eben.

With about 14 million Pis shipped in the last five years, he sees more scope for industrial IoT applications than consumer IoT products. "There's a limit to how many things you can interact with if you have a human in the loop." Eben listed a Nest-like thermostat, lighting controller, and security system: "My house is probably never going to have more than three or four consumer IoT devices."

Below Eben Upton's talk at the inaugural Global Digital Signage Conference

However, machine-to-machine interactions offer – according to Eben – almost limitless possibilities to use a Raspberry Pi. For example, many of the screens in airports now are powered by Pi Compute Modules.

IoT and security

"There's a general IoT security problem," stated Eben. "We took a network that was designed to be resilient to nuclear war and we made it vulnerable to toasters." However, security tends to get "squeezed", because "you don't need it until you need it." Further, "potentially the guy who doesn't invest in security beats the guy who did invest in security to market."

Eben sees IoT makers eventually opting for a company such as Amazon to provide an easy and robust security service. However, "I think it's going to be a while before this stuff becomes really trustworthy."

UHD Pi?

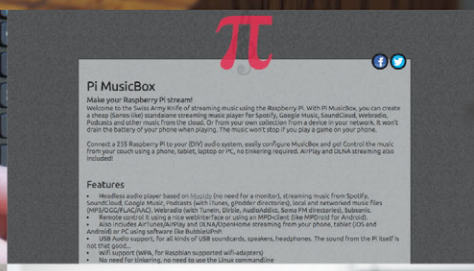
Asked when we might see a Raspberry Pi capable of Ultra High Definition (4K) output, Eben said it was "forward in our minds" but dismissed the use of a separate graphics chip. "The only rationale for a second chip would be thermal... you bake in a lot of cost if you do that." Eben estimated that "it's probably four or five years" before we'd see a UHD Pi.

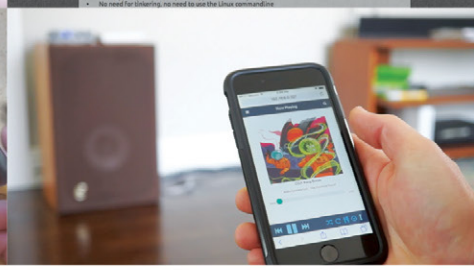
HI-FI AUDIO AT A FRACTION OF THE PRICE

MAKE YOUR OWN RASPBERRY PI NETWORK MUSIC SYSTEM

YOU'LL NEED:

- WD PiDrive Node Zero
- 90-Watt Class T Hi-Fi Stereo Amplifier
- Pi Music Box Software
- Visit our Instructable page for the full list!





Built with WD PiDrive

Join WDLabs and Maker Project Lab to learn how to build and code a dedicated digital sound system! With a Raspberry Pi Network Music System, you can centralize your music files and even stream continuously from your favorite music service, all for less than $100.

WDLABS

Get step-by-step instructions at **wdlabs.io/instructables59**

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RASPBERRY PI IS FINALIST FOR PRESTIGIOUS MACROBERT AWARD

"Redefines how people use and engage with computers"

Below Last year's MacRobert Award winner was Blatchford's Linx, the 'world's most intelligent prosthetic limb'

The Raspberry Pi is a finalist for this year's MacRobert Award, "the UK's longest running and most prestigious national prize for engineering and innovation."

"The Raspberry Pi team has achieved something that mainstream multinational computer companies and leading processing chip designers not only failed to do, but failed even to spot a need for," said MacRobert Award judge Dr Frances Saunders CB FREng.

The Raspberry Pi has helped reverse the downward trend of interest in computer science and programming. This trend "is thought to be linked to the demise of programmable home computers like the BBC Micro and [ZX] Spectrum," according to the MacRobert nomination.

Speaking at a separate event, Raspberry Pi co-creator Eben Upton corroborated this. "We used to get about 600 people applying to study computer science at Cambridge," he expanded. "We got down to about 200 – our worst year, in 2008. We had 700 [applicants] last year [2016]."

The final winner of the MacRobert Award will be announced at the Royal Academy of Engineering's Awards Dinner on 29 June.

GOPIGO 3 RELEASED

Updated robot car kit 'more versatile than ever'

Dexter Industries has launched the third version of its popular GoPiGo robot car kit, along with "a whole new operating system, DexterOS, designed specifically for learning how to program robots intuitively."

The new kit has an updated sensor board, with ports including "two I²C and two AD (analogue or digital), one serial, two servo. Everything is a lot more robust so you can daisy-chain and add on easily."

Dexter Industries' Taryn Sullivan says that the GoPiGo3 is "totally redesigned and we've added a lot of features that will be great for educators." The DexterOS software allows you or your students to build code in Bloxter (based on Google's Blockly) or Python, and is compatible with the GoPiGo2.

The GoPiGo3 should be on sale in the UK by the time you read this, from suppliers such as ModMyPi (**www.modmypi.com**). The price has yet to be confirmed, but we expect it to be around £95–100 (Pi-less).

PI-POWERED SMART METER

Welsh company delivers open-source smart appliance and accessories

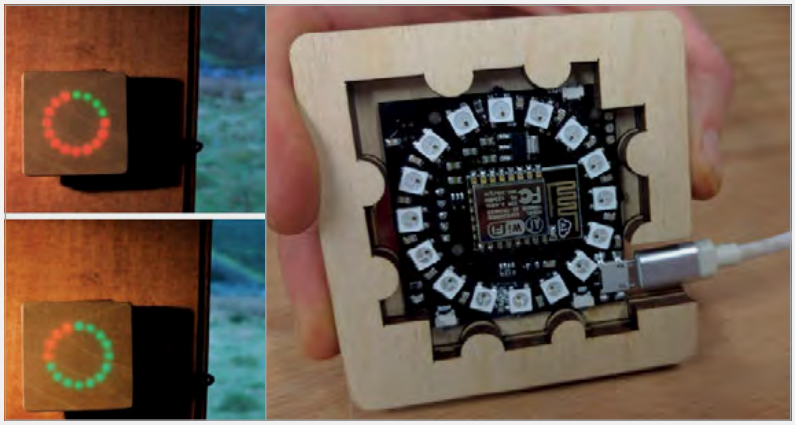
OpenEnergyMonitor's Pi 3-based emonPi monitors your energy use in real time, and coordinates all your smart- and eco-tech. Co-founder Glyn Hudson told us about the company's latest project, the emonPixel.

"For many years we've had a little LCD display called the emonGLCD. But it doesn't give a whole lot of information." Hudson informed us about his work with Energy Local (**energylocal.co.uk**), and a group of homes in North Wales, to develop a better energy monitoring system. These homeowners have four different tariffs during each day, depending on the behaviour of the nearby hydroelectric generator. "When the hydro is running, their energy bills are very, very low."

Hudson wanted an intuitive display for the current tariff, so he developed the emonPixel. Based on a NeoPixel ring, the emonPi control hub monitors the energy supply in real time, and turns quarters of the ring either red or green. If the ring is fully red, don't use the tumble dryer!

The emonPixel should be on sale soon – see **magpi.cc/2qYYukc** for details.

Below The guts of the new energy display: a NeoPixel ring with wireless capability



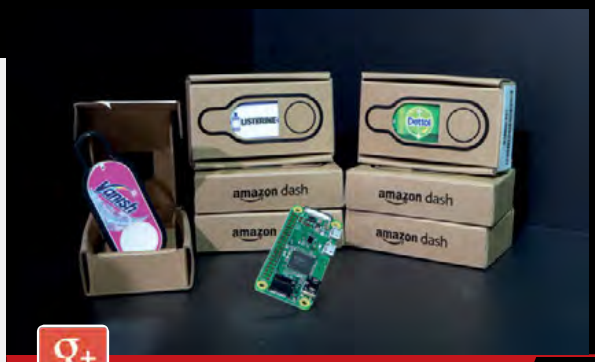
NOW TRENDING

The stories we shared that flew around the world

PIDRIVE NODE ZERO

magpi.cc/2s6L21v

Western Digital has released a cunning caddy that snugly combines a Raspberry Pi Zero with a 314GB PiDrive hard disk. Use it as a neat and low-powered NAS or file storage device.



HACK AN AMAZON DASH BUTTON

magpi.cc/2rwtTxP

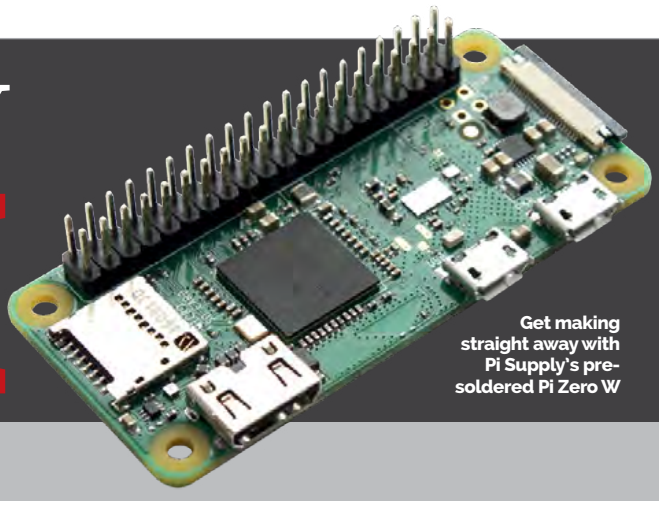
With a bit of craft and Python code, you can hack one of Amazon's £5 Dash Buttons to do pretty much anything you like. We use ours to switch on our LIFX smart lights.

PROGRAM MINECRAFT ON A PI

magpi.cc/2sit2RT

Our comprehensive guide to programming and hacking in Minecraft Pi Edition is an ideal starting point, whether you're playing, or using the game to learn coding in an exciting way.

PLUG & PLAY £10 PI



Get making straight away with Pi Supply's pre-soldered Pi Zero W

Pre-soldered Pi Zero W

Online retailer Pi Supply (**pi-supply.com**) has released a Raspberry Pi Zero W with a GPIO header. This is a boon for solder-averse hobbyists and lazy makers alike, especially as the pre-soldered Pi costs only £14. Visit **magpi.cc/2sUWhds** for details.

Pi Supply owner Aaron Shaw tells us, "We think the Raspberry Pi Foundation absolutely did the right thing by not including a header as standard because it's unnecessary for many projects and adds a significant cost! However, for some projects this is an annoyance and a header is needed."

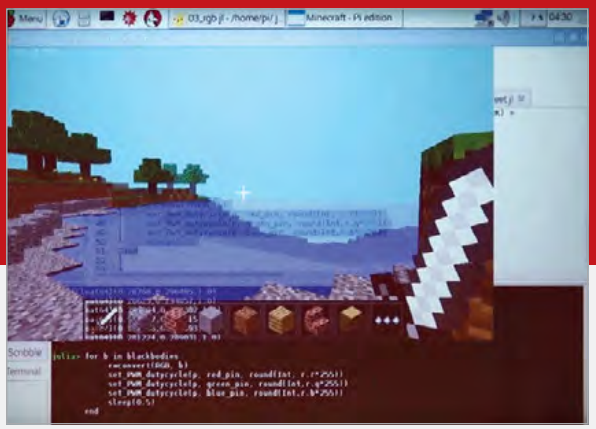
Shaw says that pre-soldering the GPIO header "turns the Pi Zero into something completely plug and play, the minute it falls through the post box. And we test them before they ship out."

We wondered who was doing all the laborious soldering: "For the first 100 units, we did these by hand between four of us… we have now outsourced it to our lovely contract manufacture partners based in the UK."

The pre-soldered Pi was first listed on 12 May and "they have been selling fantastically well." Pre-soldered or not, you can still only buy one Pi Zero W per order.

JULIA ON PI

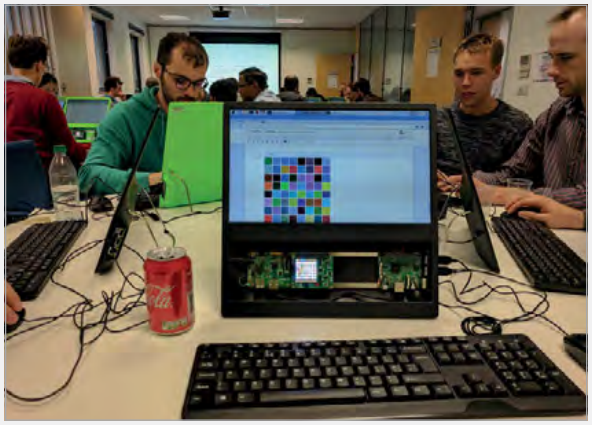
Fast and powerful coding language ported to the Raspberry Pi



Above Julia can be used for less serious applications as well as more complicated tasks. Image: JuliaCon 2016

Julia has been ported to the Pi, allowing scientific researchers, data analysts and hobbyists alike to experiment with the next-gen programming language.

Viral Shah, co-creator of Julia, explains to us that "workstations crunching data is the typical picture" for scientific computing, but "I just got myself a Pi 3 and a Sense HAT. With all the computing power and sensors there, it makes sense to crunch data on the device itself."



Right Julia running on a Pi with a Sense HAT

Julia isn't just for scientific analysis, crunching huge data sets, or statisticians, though. "Julia was designed to solve the two-language problem: the speed of C++ and Fortran with the ease of use of Python. There are increasingly many application domains where Julia is a great fit." We've seen demonstrations of Julia being used to hack Minecraft, and to build the AI in an autonomous RC race car. Julia currently offers support for the Pi's GPIO, the Sense HAT, and Minecraft Pi.

To start playing with Julia, follow the download instructions at **juliaberry.github.io**.

PI CLUSTER POWERS NEXT-GEN MEDICAL RESEARCH TOOL

Semantic search meets affordable hardware

UK-based SciBite recently demonstrated its cutting-edge biomedical semantic search tools on a humble Raspberry Pi cluster.

The demonstration was part of SciBite's setup for the Bio-IT World show in Boston, USA, where SciBite won an award for Best of Show in the Analysis and Data Computer category. "The show went really well," SciBite marketing manager Monica Kulkarni tells us, with a "great reception for the Pis. People came to the stand just to see the demo.

"The great thing about using the Pi cluster," Monica continues, "was that when the internet connection went down in the exhibition hall, we could carry on demonstrating, as the Pis ran on their own local network."

'Semantic search' is a method of information gathering far in advance of using a standard search engine, Monica explains. "Controlled scientific vocabularies" allow the TERMite semantic search tool to understand that "for any given concept, there may be multiple synonyms for a singular term. Schilder syndrome, Alpers' disease, Christensen disorder, Encephalitis periaxialis are all the same disease." The "tens of millions of synonyms provide the depth of knowledge required to understand biological text."

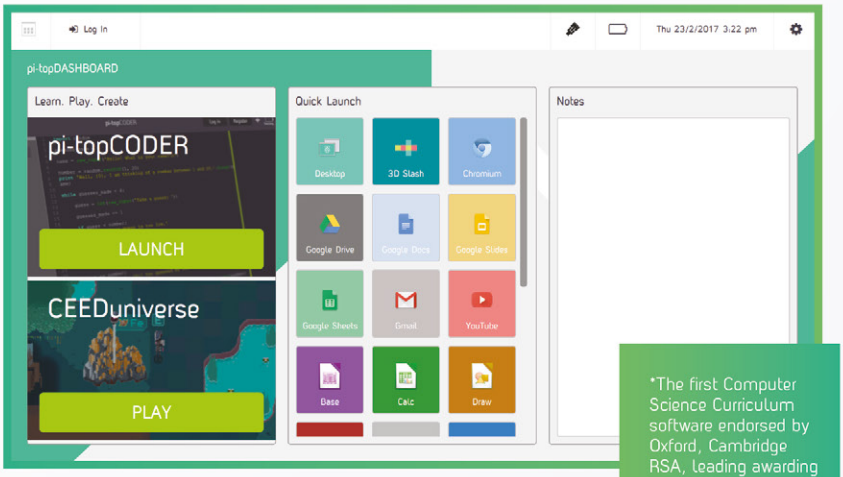
However, ambiguity is also a problem, with a single word having many meanings, and therefore producing either irrelevant or misleading search results. "Contextual disambiguation is critical to ensuring accurate insight," confirms Monica.

TERMite, and the DOCstore front-end that accesses it, is platform-agnostic (it's a Java app with a browser-based UI), but developing for the Pi wasn't just for fun. Squeezing the TERMite vocabularies to run on the Pi's 1GB of RAM was a challenge, but "some of the techniques we used to compress and efficiently scan data … are already finding their way into next release of TERMite."

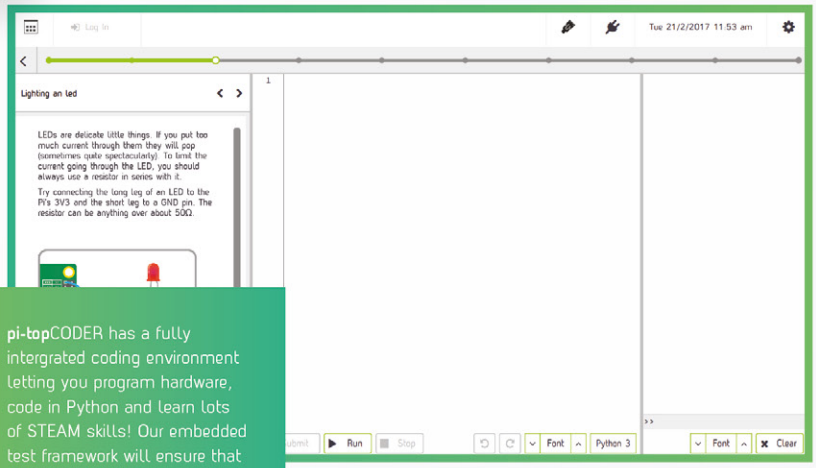
Above A cluster of four Raspberry Pis in a master-slave configuration hosts and executes SciBite's next-gen search tool

pi-topOS

The OCR* endorsed **pi-top**OS (Operating system) platform comes pre-installed on the 8GB SD card shipped with every unit. **pi-top**OS software suite lets you - browse the web, - check emails, - create and edit Microsoft Office compatible files. It includes **pi-top**CODER and comes with the revolutionary educational game CEED**universe**.



*The first Computer Science Curriculum software endorsed by Oxford, Cambridge RSA, leading awarding body - **OCR**.



pi-topCODER has a fully intergrated coding environment letting you program hardware, code in Python and learn lots of STEAM skills! Our embedded test framework will ensure that you understand all concepts.

pi-topCODER

pi-topCODER is the interface that allows you to access worksheets and pre-built Raspberry Pi projects. It's the easiest way to tinker or deliver lessons by providing step-by-step guides for computer science and STEAM worksheets.

CEED**universe**

CEEDuniverse is our educational game. It's a world of fantasy developed in line with the computing curriculum – taking science fiction and transforming it science. It is a FREE massive role-play game carefully crafted by **pi-top**. The game teaches students to solve computational puzzles, how to code in Python and build physical circuits which interact with the game.

Exploring the planet, the students first encounter 'drag & drop' coding puzzles and move on to writing text based code.

MINIGAMES

Learn programing concepts through our minigames, for example learn problem decomposition by solving visual programming puzzles.

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POWERED BY RASPBERRY PI

LEARN
PLAY
CREATE

pi-topCEED

The modular all-in-one
Raspberry Pi powered desktop

- Adjustable Viewing Angles
- 14" HD Screen
- Modular Components

pi-top

The modular build-it-yourself
Raspberry Pi powered laptop

- 10 Hour Battery Life
- 13.3" HD Screen
- Modular Components

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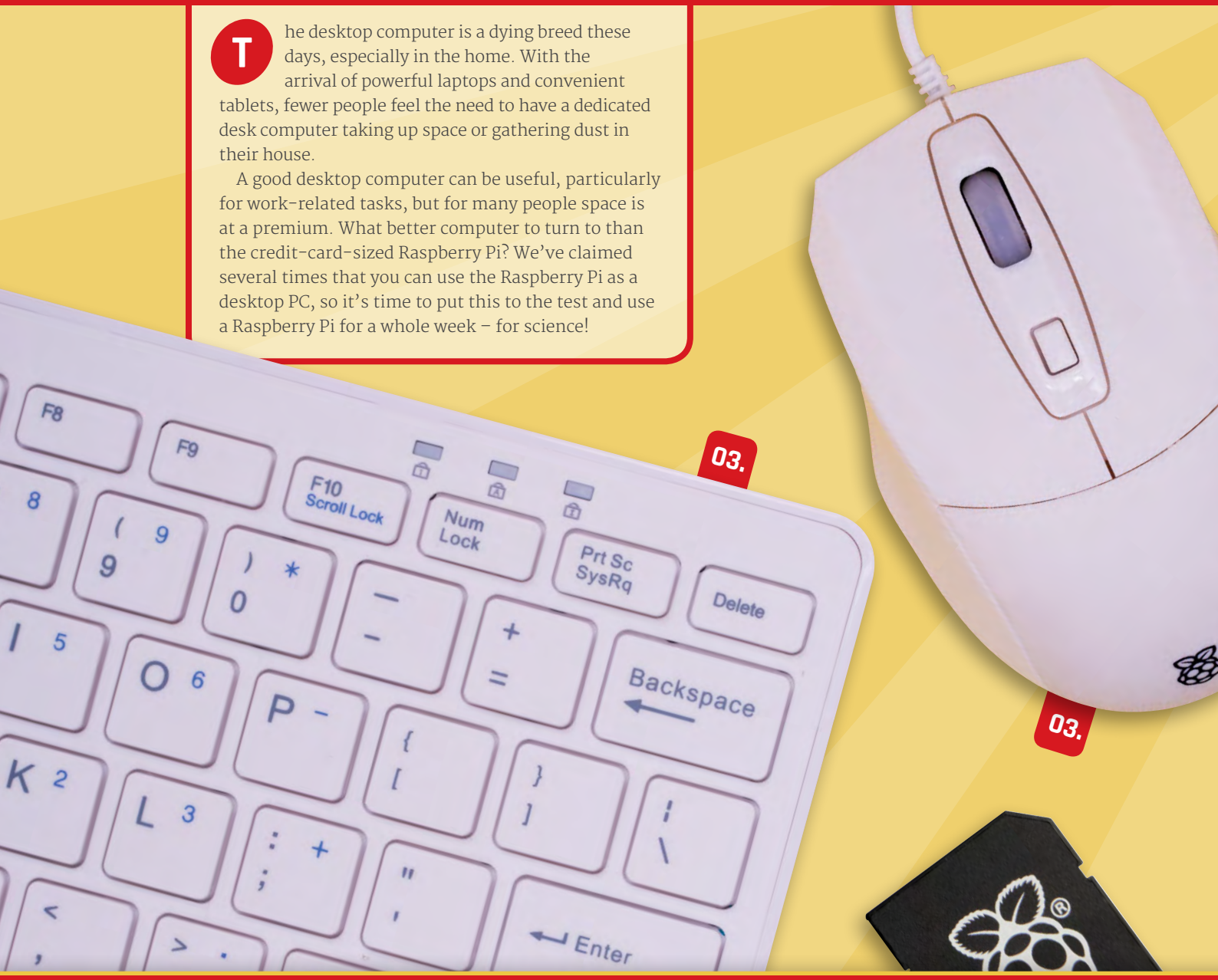
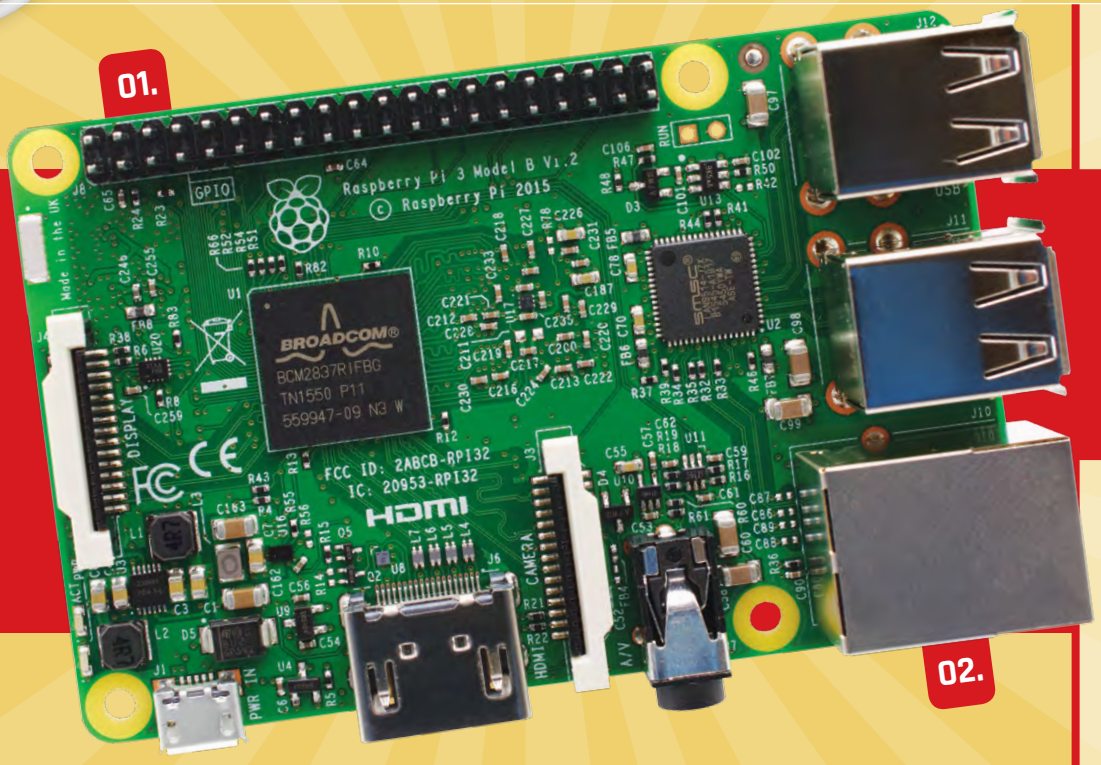
The RASPBERRY PI PC CHALLENGE

Can you really use a Raspberry Pi as a desktop replacement? We set Rob Zwetsloot the challenge of using a Pi for a week

The desktop computer is a dying breed these days, especially in the home. With the arrival of powerful laptops and convenient tablets, fewer people feel the need to have a dedicated desk computer taking up space or gathering dust in their house.

A good desktop computer can be useful, particularly for work-related tasks, but for many people space is at a premium. What better computer to turn to than the credit-card-sized Raspberry Pi? We've claimed several times that you can use the Raspberry Pi as a desktop PC, so it's time to put this to the test and use a Raspberry Pi for a whole week – for science!





Rob's Desktop Setup

01. RASPBERRY PI

For one week, I'll be working on a Raspberry Pi. I've chosen the Raspberry Pi 3, as it's the most powerful Pi to date, and I'm going to need all the power I can get.

02. ETHERNET PORT

My test used wireless LAN for internet access, but you can easily wire up an Ethernet connection if you prefer.

03. KEYBOARD & MOUSE

The classic desktop setup isn't complete without the standard mouse and keyboard – no touchscreen or motion-sensing devices in sight!

04. HARD DRIVE

External storage is essential, as SD cards offer limited space.

Also...

MONITOR

The Raspberry Pi 3 can display 1080p visuals over HDMI, so I've chosen a monitor that can handle this.

RASPBIAN

I've chosen Raspbian for this experiment. Not only is it the premier Raspberry Pi OS; it is also well supported by the community, so I can easily get help if I need it.

Day One: SETTING UP

I built the basic hardware setup as described on the previous page. I downloaded and installed the latest version of Raspbian (you can do this via NOOBS, or follow our instructional video: **magpi.cc/2sj7IeN**) and let it run through its automatic setup steps. With that, I was ready to start using the Raspberry Pi as a desktop computer. Let's begin.

Know your software

If you're using the Raspberry Pi for sysadmin or other kinds of IT management, you're not going to demand much from it. The trusty Terminal will be your best friend, along with a quick peek at Google to check Stack Overflow.

I'm treating my Raspberry Pi as an office desktop computer. For writing magazine articles, this means I'm about 95 percent covered by a word processor and an accompanying office suite, a web browser for general internet usage, and access to relevant chat protocols so I can coordinate with the rest of the team. These requirements will be the same for a lot of office workers. Let's take a look at the tools you're getting on Raspbian to help with this.

Web browser: Chromium

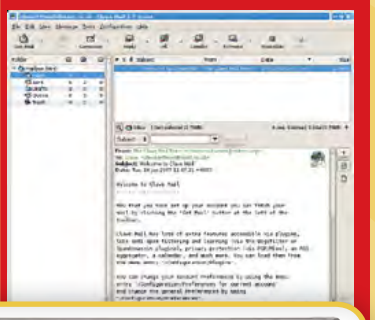
This default browser (and the base for Google's Chrome browser) comes with all the major features of Chrome itself, including the ability to transfer over your settings and Chrome apps. This version of Chromium also comes with Flash integration.

Rob thinks: Chrome is my preferred browser, and we also think it (as Chromium) is the best browser available for the Raspberry Pi (read our group test on page 78). Most importantly for this experiment, it allows for great access to web versions of software that may not have a Raspbian equivalent, such as Skype.

Email: Claws Mail

A very lightweight email client that comes bundled with Raspbian. You can use it like any other email client.

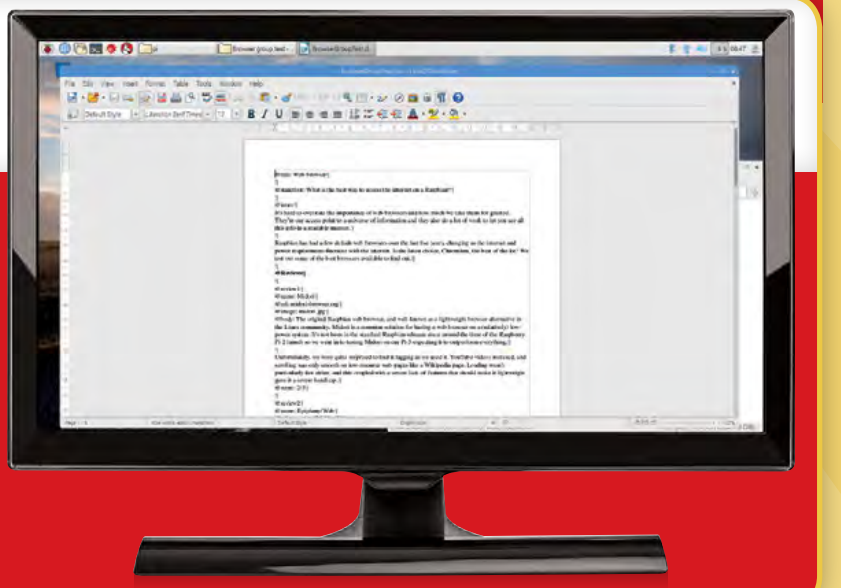
Rob thinks: Claws is fairly basic, but if all you really need to do is read and reply to emails, you don't need much else.



Office suite: LibreOffice

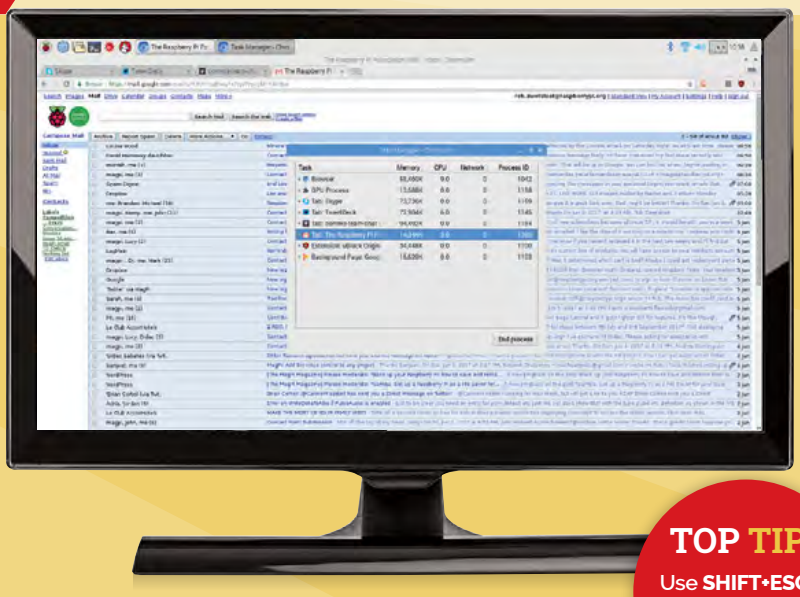
One of the most popular alternatives to Microsoft Office, LibreOffice includes a range of equivalent programs that are compatible with Microsoft Office files. Writer is your Word replacement, Sheets replaces Excel, Impress works with PowerPoint files, etc.

Rob thinks: I really like the LibreOffice apps, and Writer is a perfect substitute for Word and other word processors. This version of LibreOffice has been further optimised to look and run better on the Raspberry Pi as well, so you won't notice any performance issues.



CHROMIUM TIPS

Here's how I used the Chromium browser to handle multiple tasks



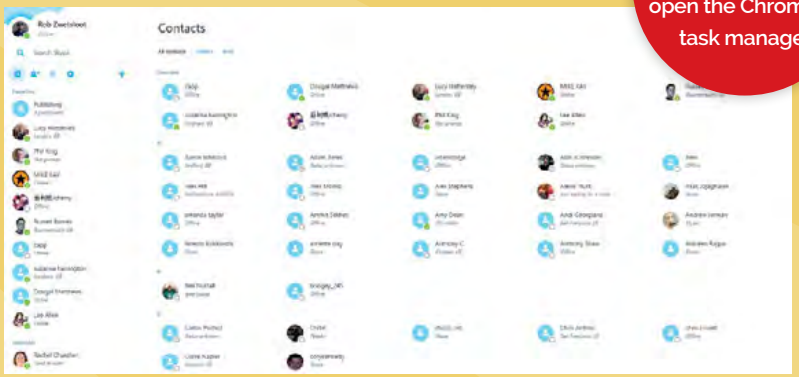
We spend a lot of our lives online, accessing everything from email and search engines to news and social media, as well as web versions of popular software. Here are some of my top tips for making the most of your browser on Pi.

Gmail

While I could access my Gmail through Claws Mail, I was interested in seeing whether I could get Gmail running in the browser. Surprisingly, Gmail takes up a lot of memory space while it runs. This increases as you add different accounts.

Luckily, Google has a solution: switching to HTML mode while loading. Google claims that this is to help with slow connections, but it also drastically cuts down the memory footprint. It looks as if you're using Gmail in 2002, but it's worth it.

TOP TIP: Use **SHIFT+ESC** to open the Chromium task manager

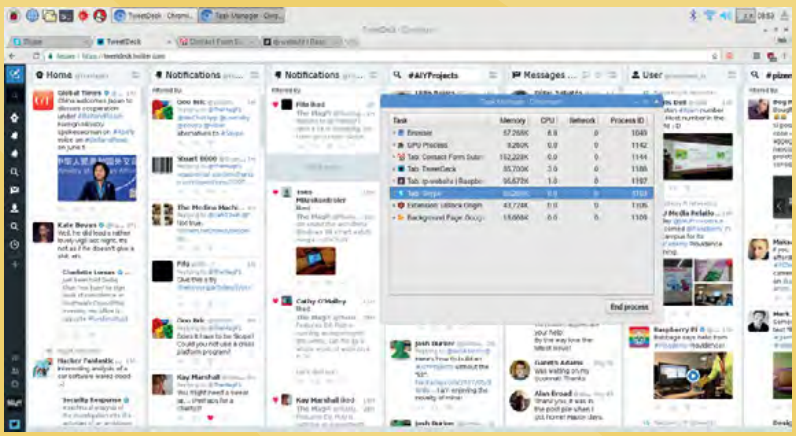


Skype

We use Skype for chatting at *The MagPi*, and while there are other chat protocols that might be easier to tap into (such as Hangouts), we can't change the way we work just for one person. I decided to try web Skype (**web.skype.com**), and while it wasn't particularly kind to the memory resources, it did run happily in the background while I got on with other work.

I turned off some of the chat features (including the giant animated emoticons), and I suggest that you do the same.

TOP TIP: Use a different chat client. Try out Pidgin for a very lightweight way of staying in touch



TweetDeck

You may not use Twitter enough to need TweetDeck to manage all your accounts, but I was pleasantly surprised at how well it worked. It does use a lot of memory, but it runs just fine on the Pi, even when other programs are up and running.

Day Two: ZEN AND THE ART OF TAB MANAGEMENT

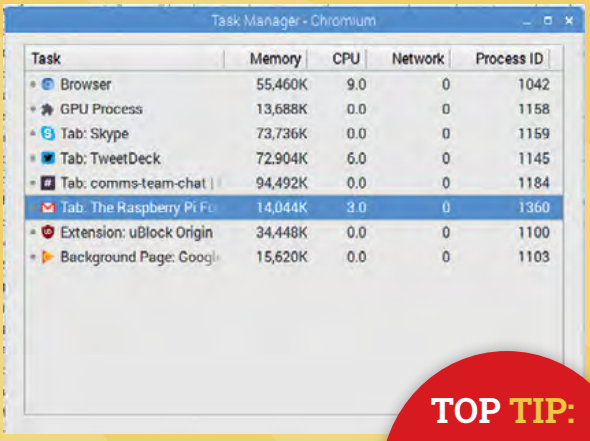
In 2017, access to the internet is essential. This means that your Chromium browser is going to be running for most of the time while you're using your Pi as a desktop, even if it's in the background. As the Raspberry Pi offers limited resources compared with a modern desktop, you won't be able to have 15 tabs up and running at once. Here's my advice on how to maximise your browser efficiency.

TOP TIP: If you're having serious performance issues, close and restart Chromium

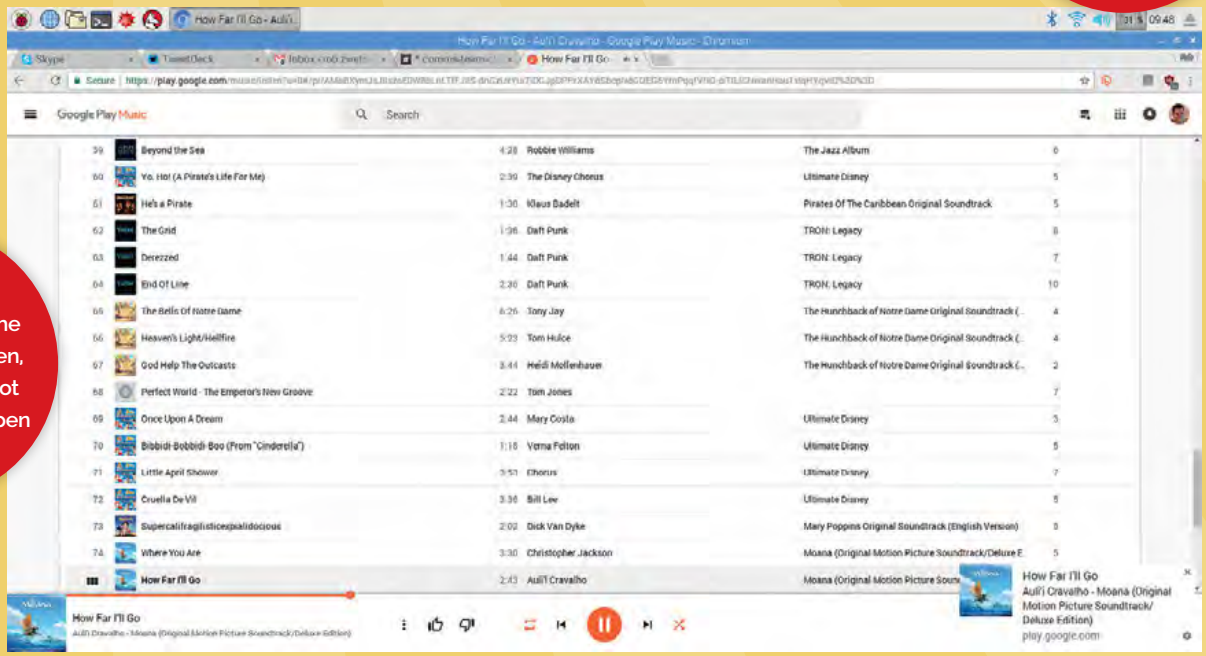
Open and close tabs

I spent the week working with four or five reasonably resource-intensive tabs open at a time, and that was probably stretching the abilities of the Pi. These included Skype web chat, Slack, TweetDeck, and Google Music (which I'll discuss over the page).

Adding extra tabs starts to make Chromium a little wobbly, so I decided to close down tabs when they weren't essential. Slack and TweetDeck were good choices; I could come back to them, but closing the tabs removed a distraction for a time, allowing me to focus on work.


Task Manager - Chromium
Task | Memory | CPU | Network | Process ID
Browser | 55,460K | 9.0 | 0 | 1042
GPU Process | 13,688K | 0.0 | 0 | 1158
Tab: Skype | 73,736K | 0.0 | 0 | 1159
Tab: TweetDeck | 72,904K | 6.0 | 0 | 1145
Tab: comms-team-chat | 94,492K | 0.0 | 0 | 1184
Tab: The Raspberry Pi Fo | 14,044K | 3.0 | 0 | 1360
Extension: uBlock Origin | 34,448K | 0.0 | 0 | 1100
Background Page: Googl | 15,620K | 0.0 | 0 | 1103

TOP TIP: Check the task manager to see which tabs are taking up the most resources



TOP TIP: Keep an eye on the tabs you have open, and whether or not they need to be open all the time

DOS & DON'TS

Which websites should you avoid?

Keep an eye on memory

One of my best friends during the week was the Chromium task manager: you can access it using **SHIFT+ESC** or open it from the Chromium menu. It displays a basic process list, giving memory and CPU usage for each tab and service.

In this instance, the Raspberry Pi is limited more by memory than by CPU power. I found that tabs using about 100-150k of memory were at the upper limit of what the Pi could handle, and you really shouldn't have too many of them running at the same time. I used this information when deciding which tabs to keep open.

TOP TIP: Use your mobile phone as a second screen and/or music player

Phone backup

I don't know about you, but I have a lot of the important notifications I need (work email, work chat, etc.) tied to my phone as well as to the desktop for when I'm out and about. It's not unusual to get a ping about a work email on my phone and then check Gmail in the web browser to read it.

While I completely understand if you'd rather keep work off your personal phone, notifications are easy to turn on or off, or even schedule on modern smartphones. I was happier to close non-urgent browser tabs when I knew that my phone would beep at me if something required my attention.

Alternatively, while I chose to run a music streaming service through the browser on the Raspberry Pi, I could easily have done so via my phone instead, which would have freed up some extra memory.

SOCIAL MEDIA

Twitter

Twitter is a simple site, and I had very little trouble using it. As I mentioned before, TweetDeck is a great way to make the most of Twitter without causing the Pi to struggle. You can easily handle pictures, GIFs, and video through Chromium using TweetDeck.

Facebook

Facebook is very resource heavy and I struggled to use it unless it was the only tab running in Chromium. If you're planning to use a Pi desktop purely for social media management or browsing, you won't need as many tabs open, so you'll probably be fine. Otherwise, be careful with Facebook.

MEDIA

YouTube

Everyone's favourite repository of cat videos, YouTube runs well on the Raspberry Pi via Chromium. Make sure you have some speakers or headphones plugged in. If you need to, right-click the volume button in the top right-hand corner of Raspbian and change it to Analog.

Other video

Your mileage may vary, but other video sites or news sites that don't use embedded YouTube videos don't work as well as YouTube. Again, this will be dependent on the number of tabs you have open at any time.

Day Three: MEET THE COMMAND LINE

It is perfectly possible to use Raspbian or any other Linux distribution solely through the graphical desktop. However, getting to grips with the command line or Terminal is essential to make sure your Raspbian experience is as smooth as possible.

I found myself periodically having to enter the command line to troubleshoot issues I'd discovered during the experiment. Here's how it works.

Know the difference

Command line

The classic computer interface. There are no fancy graphics here, just lines of text. You can use the computer by running commands here.

Access:

Access the command line using **CTRL+ALT+F1**. Return to the desktop with **CTRL+ALT+F7**.

Terminal

Also known as the terminal emulator, this program allows you to run commands from inside the graphical desktop environment. The best of both worlds!

Access:

Click on the Terminal program in the toolbar. The icon shows a window with a black screen.

TOP TIP:

Need to know the Raspbian user name and password? The default user name is **pi**, and the password is **raspberry**

Command-line basics

Some essential commands you need to know

sudo allows you to run commands as the owner of the operating system

```
sudo apt-get update
```

Before installing software or updating your version of Raspbian, this command will let your installer know which software updates are currently available. Online versions can change regularly.

```
sudo apt-get upgrade
```

After updating the software list, you can then upgrade any software that has a newer version online. This can take anywhere from five to 30 minutes, or even longer, depending on how long it has been since your last upgrade.

```
sudo apt-get install [software]
```

You can install software using the apt-get install command, followed by the relevant package name. There is also an option to add and remove software using the graphical desktop.

```
sudo reboot
```

Use this to safely restart the Raspberry Pi.

```
sudo shutdown -h now
```

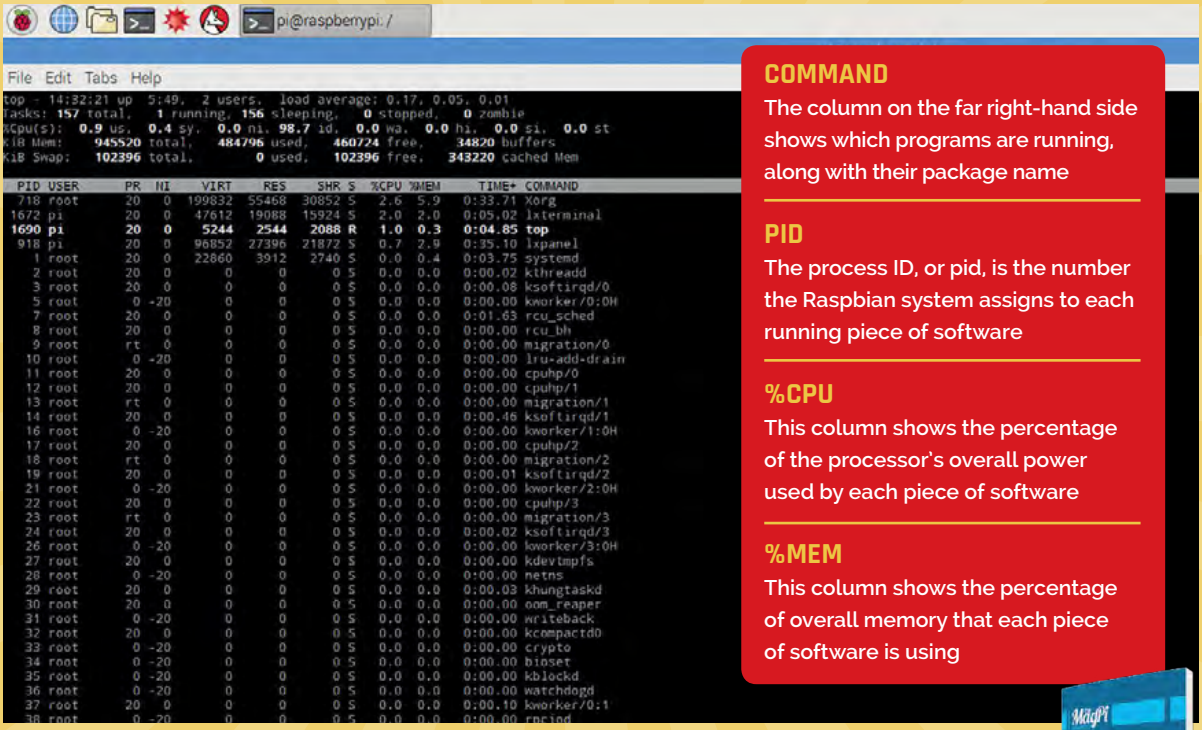
Use this to safely switch off the Raspberry Pi.

```
startx
```

From the command-line interface, you can enter the graphical desktop using this command.

TROUBLESHOOTING IN THE TERMINAL

Got a problem? Pi running slow? Try these simple fixes



COMMAND
The column on the far right-hand side shows which programs are running, along with their package name

PID
The process ID, or pid, is the number the Raspbian system assigns to each running piece of software

%CPU
This column shows the percentage of the processor's overall power used by each piece of software

%MEM
This column shows the percentage of overall memory that each piece of software is using

Like the task manager in Chromium, Raspbian has its own task manager known as **top**. You'll need to access it through the command line, by entering **top**. Once you've opened it, you can do some minor troubleshooting and ease the strain on the Raspberry Pi if it's struggling.

Stopping processes

In my experience, applications that use a lot of memory are the ones that cause the most trouble for the Raspberry Pi. If something uses a lot of CPU power as well, that will also slow down the Pi.

Using the columns displayed by **top**, you can determine which processes are taking up the most resources. Use the left and right arrow keys to change which column to sort the list by, so that when it updates you don't lose track.

Press **k** when you locate the resource-hungry program, and enter the pid to stop the process.

Command-line Essentials

Like working in the command line? Then you should check out our book, *Conquer the Command Line*, for more ways to use it: **magpi.cc/Essentials-Bash**.

Alternatively, you can press **q** to quit top and enter the following command:

```
sudo kill [pid]
```

If you need to stop a lot of processes with a similar name, you can also use:

```
sudo killall [name]
```

Not fixing your problem? The best place to look for solutions or ask questions is in the Raspberry Pi forums: **raspberrypi.org/forums**.

Day Four: GETTING DOWN TO BUSINESS

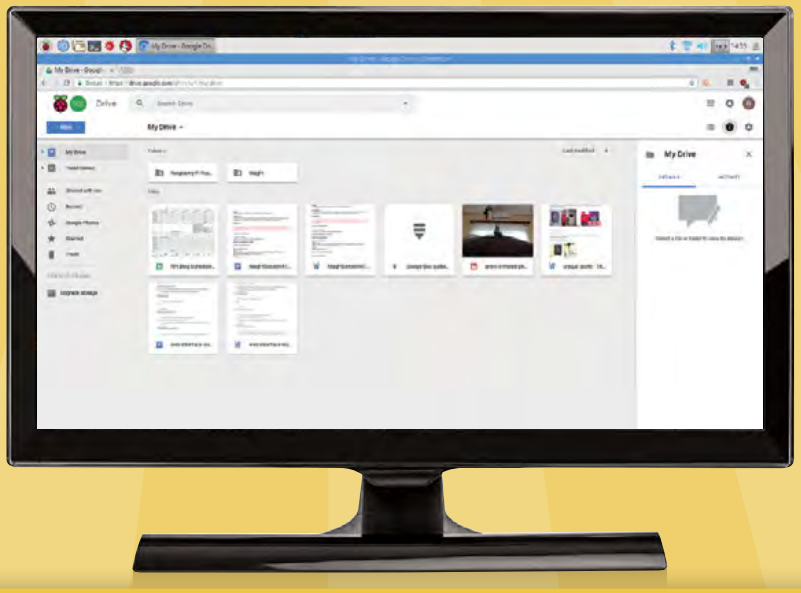
A few days into our experiment, I found myself facing some admin tasks, so I was using more Office-style programs than on previous days. I needed access to collaborative documents from Google Docs and Sheets, and to WordPress for writing blog posts. Here's what I needed to achieve, along with some of my solutions.

Google Drive

Using online collaborative spreadsheets and documents

As I discovered earlier in the week, juggling Chromium tabs is essential to keep the Raspberry Pi running well. Google Drive and Google Docs use large amounts of resources, so keep that in mind when working with them.

I recommend trying to use one document at a time, or to close as many other tabs as possible if you need to juggle more than one. If you keep this in mind, Docs and Sheets work well in the Chromium browser, so you shouldn't need to make any further changes to get them running.



TOP TIP: set up Dropbox on a Raspberry Pi using the guide here: **magpi.cc/2c9NnPC**

Dropbox

Making the most of cloud storage

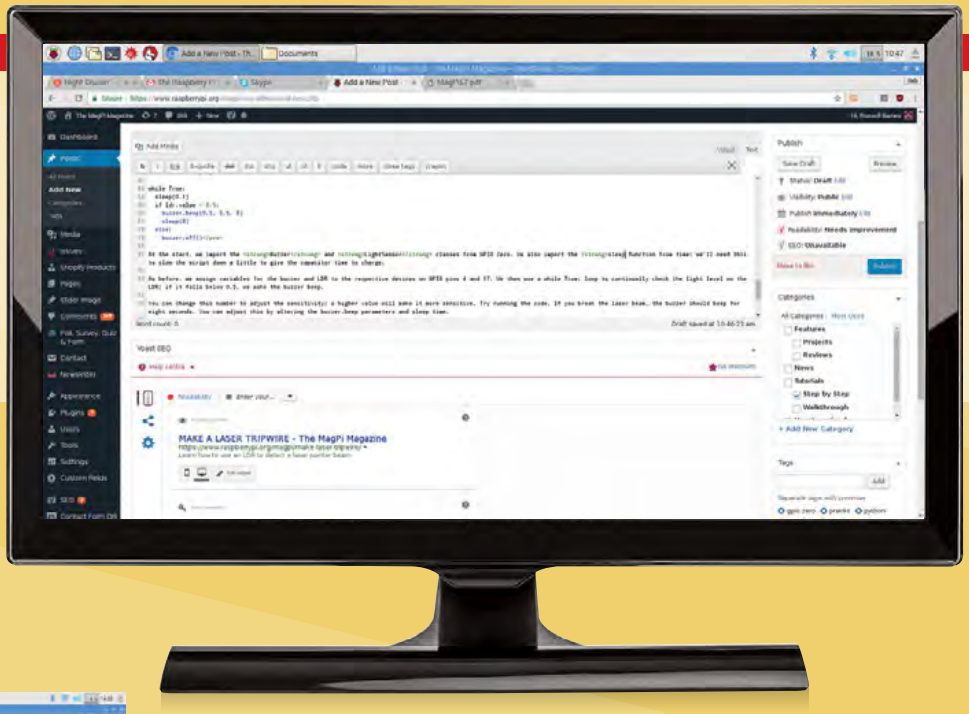
A lot of *The MagPi* files live on a shared Dropbox that we use to create the magazine, and we all need to upload articles as well as monitoring the production process. There are two main ways to make this work: follow our previous tutorials and install Dropbox to Raspbian, or make use of the Dropbox web interface.

There are advantages to both options. Creating a dedicated Dropbox folder is a lot faster and frees up all-important browser resources, while the web interface allows you to quickly access, download, and upload a few files at a time. While I used the web interface method this time, I have used Dropbox on a Pi before. If this were a more long-term solution, I'd set up Dropbox on an external hard drive. This makes everything easier, although it takes a while to set up.

PDF

How to read PDFs on the Raspberry Pi

Opening a PDF on the Raspberry Pi is easy – there's a dedicated PDF reader installed. Opening PDFs in the browser can cause problems, though. Chromium has a habit of trying to load PDFs into the browser without downloading them first. This is fine on a normal desktop computer, but it doesn't always work on the Pi.



If you're having trouble reading a PDF online, download it first and open it in the default program. If you need to copy text from it, you'll need to open it in Chromium. Open a new tab, then drag and drop the downloaded PDF onto Chromium to load it.

Blogging

Things to keep in mind while using WordPress

I didn't have any big problems while writing *The MagPi* blog posts. The main thing that caused the Pi to slow down was adding images directly into the posts. I'd recommend uploading them to the Media library first, before embedding them in a post.

Other services

I've probably missed out something you use regularly – we don't all use our computers for the same things! Here are a few tips on troubleshooting your desktop Pi experience.

- Use Google to search for lightweight alternatives to the software you normally use
- Experiment with several pieces of software until you find the one that works for you
- Be wary of fancy web interfaces; these will take up a lot of resources
- Above all, be patient

Image editing

A lightweight alternative to Photoshop

I don't expect to do any serious image editing or touch-ups on a Raspberry Pi, but the ability to perform simple editing tasks (crop, rotate, resize) is important. Mirage is the software that allowed me to do this in Raspbian. It is very lightweight and works well. The display also includes a column showing all the images in a selected directory. It was quick and efficient for the simple tasks I needed, although for anything more complex you'll have to seek out a more powerful computer.

Day Five: MAINSTREAM MEDIA

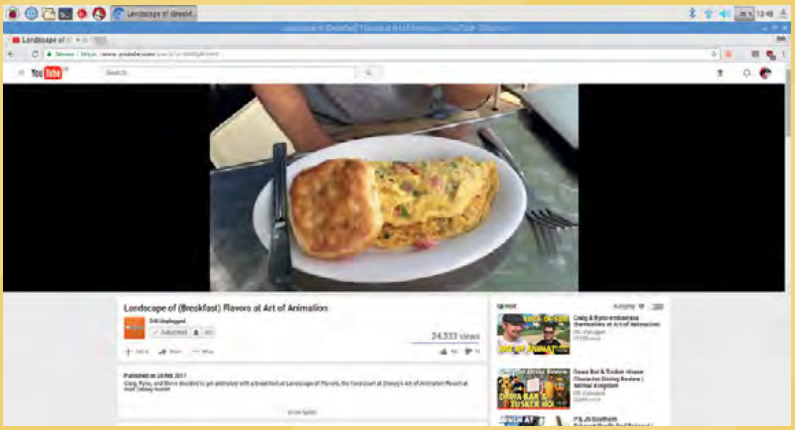
I wanted to relax on the evening of the final day, by watching some TV and playing some games. While I'm performing this experiment, I thought I'd give it a go on the Raspberry Pi. How did my trusty little computer fare?

WATCHING

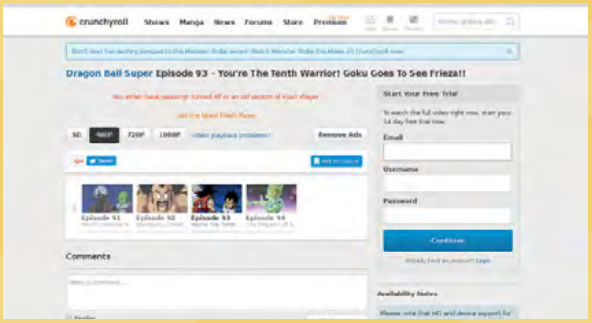
YouTube & online video

As we've discussed before, YouTube works just fine on the Raspberry Pi with Raspbian and Chromium. I caught up with my YouTube subscriptions (handily placed in a Watch Later playlist) while sipping a tropical, rum-based concoction I'd devised to celebrate the end of the week. I daringly took my viewing into fullscreen mode, which juddered a bit when it started but performed well over the next half hour or so as I switched between a selection of videos.

Below Don't judge me: I'm going to Walt Disney World soon...



Below Can Goku recruit Frieza for the Tournament of Power? Find out next time on *Dragon Ball Super*...



I haven't had much luck with other types of online video this week. However, this task only used one tab in my browser, so I thought I'd push the envelope a bit and see whether I could catch up on *Dragon Ball Super* via Crunchyroll. Unfortunately, instead of providing the low-quality playback I had come to expect, the video player just refused to load, leaving me unable to find out whether Goku had reached Super Saiyan Blue 2!

I had similar problems with Netflix while trying to watch some of the new *Unbreakable Kimmy Schmidt* episodes. There are solutions to fix this issue (**magpi.cc/2rDbtaE**), but they're not available by default.

Verdict:

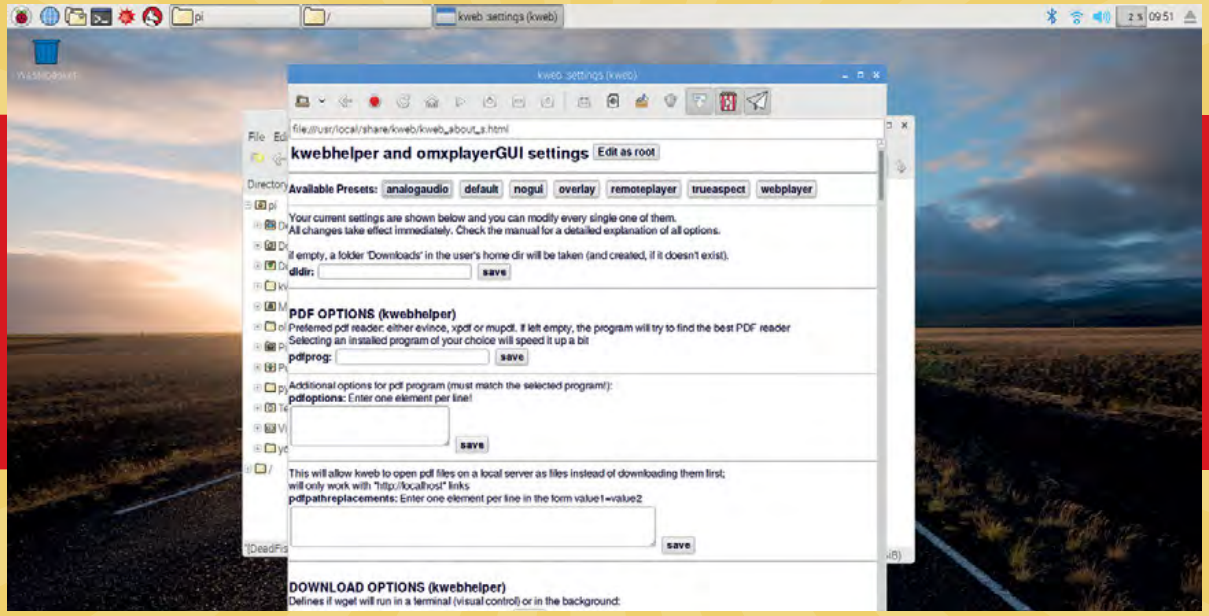
Hit and miss for online video, but at least YouTube worked well

PLAYING

Pi-compatible games

Minecraft Pi

A slimmed-down version of Minecraft, Minecraft Pi is great for making forts in mountains, and that's before you start hacking it with your own mods! To run Minecraft Pi, open it from the desktop menu or type `minecraft-pi` in a Terminal window.


kweb settings (kweb)
kwebhelper and omxplayerGUI settings
Edit as root
Available Presets: analogaudio default nogui overlay remoteplayer trueaspect webplayer
PDF OPTIONS (kwebhelper)
DOWNLOAD OPTIONS (kwebhelper)

Left The settings file may look a little basic, but it gives you full control over the program

Network video playback

One cocktail down and with another to go, I decided to see how well the Raspberry Pi would handle streaming video over the network. The Pi has hardware decoding for HD video and I've run some playback with it before, so I was interested to see how it would all work. I have a file server on my network (powered by a Raspberry Pi, of course), so I connected to it and had a go.

Omxplayer is bundled with Raspbian, and it provides one of the best ways to play video on the Pi. While it is a Terminal app, a GUI that will automatically play your videos is available (via the kweb suite: **magpi.cc/2sTExQo**). I did need to change the audio output settings: open the GUI via Menu > Sound & Video, click on Edit Settings, and then click on the analogaudio button at the top of the settings page.

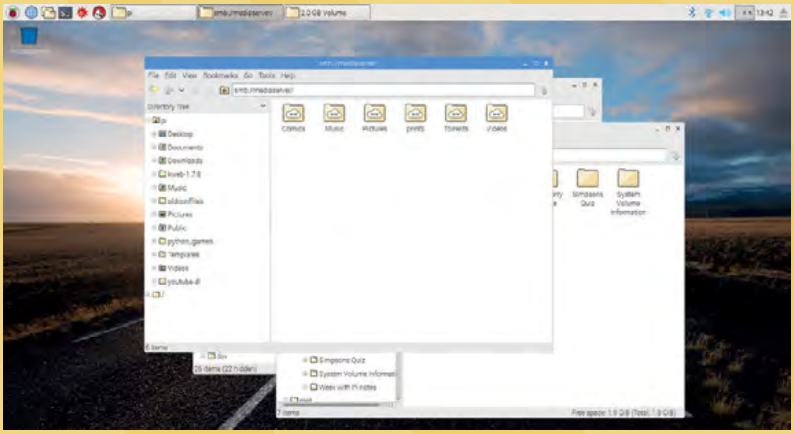
The video playback might not line up with the interface, but the HD video plays just fine, using the space bar to pause and play. I like to watch anime and tokusatsu shows, which usually come encoded in 10-bit colour. While Omxplayer will play them, expect some glitches as the Pi doesn't support 10-bit hardware decoding.

Verdict:

A very similar experience to using a video player on a normal desktop, thanks to Omxplayer

Connect to a Network Shared Folder

You can quickly connect to a Samba/Windows shared folder by opening File Explorer (the folder icon) and typing into the address bar `smb://` followed by the IP address of the computer, or its name on the network: `smb://mediaserver`



Above Easily view your files over the network using Samba - it can be used for more than just streaming media!

Super Crate Box

A fun little game from Vlambeer that is available as a Gamemaker game for the Raspberry Pi. Get it here: **magpi.cc/2s8tdhK**

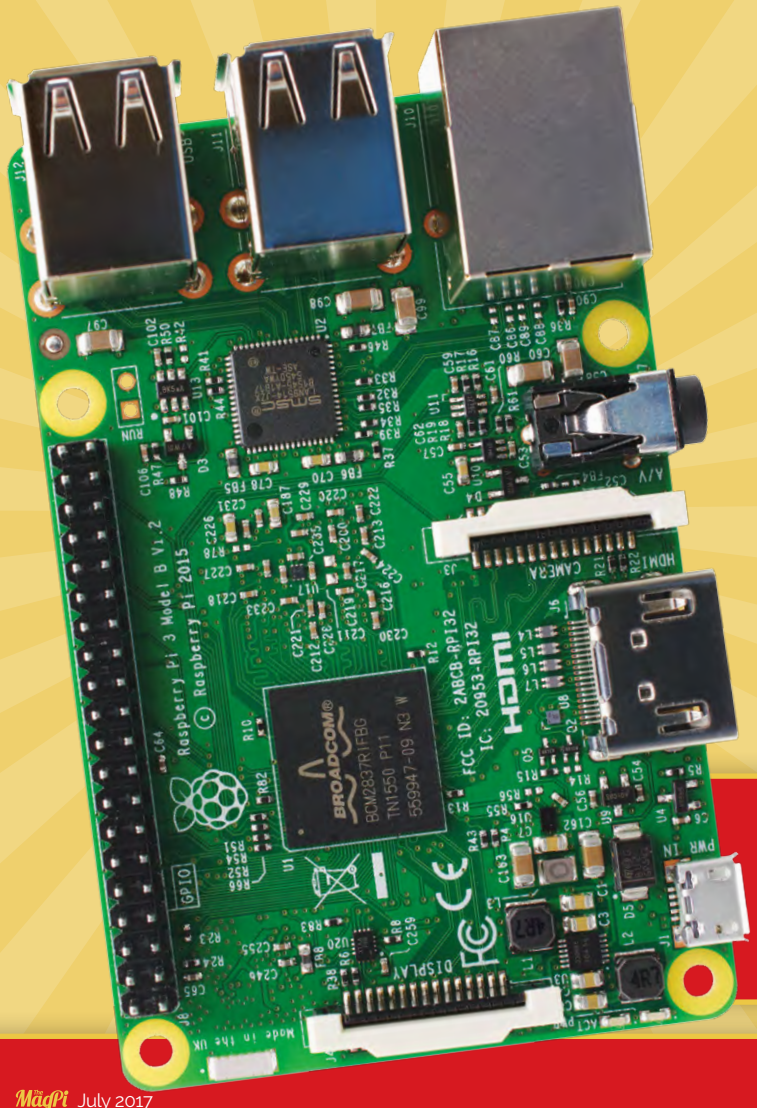
Scratch games

I always enjoy having a quick look at the Scratch website to see what fun little games I can find for the Pi: **scratch.mit.edu**

WHAT WE LEARNED

The experiment is over: here's what I thought of the week

Going into this experiment, I wasn't sure what to expect. I've been using the various models of Raspberry Pi for more than five years now, in all manner of ways, but never as a full-on desktop replacement. I knew the Pi was capable of the individual tasks I'd need to do, but I was wary of trying to get them all running together.



As I've explained, juggling all my tasks was a little taxing on the Raspberry Pi, and I had to learn to prioritise my tasks and software to guarantee the best performance. I also had to remove the power a few times, so I learned to save anything important to external storage in case the SD card corrupted.

I learned two main lessons from the week with Pi...

Patience:

The Raspberry Pi, like any computer, can only do so much at once. The Pi is a bit more limited than a modern laptop or desktop computer, so you can't expect it to immediately load all the elements of a webpage or instantly open the document you're working on.

If it seems to hang, give it some time to sort itself out before you start killing programs or consider pulling the plug.

Compromise:

Like all relationships, using the Raspberry Pi as a desktop computer involves some compromise. Sure, I'd love to have all the things I need to work on running at once, but the Pi can't quite handle them. Instead, I moved my music listening to my phone, I made sure that windows and software were closed when they weren't needed, and I used the HTML Gmail interface for my email.

All this resulted in increased efficiency during my work day in some ways, but other tasks took longer, so it balanced out overall.

The Result

After my week with the Raspberry Pi 3, I'd say that it is perfectly suitable for using as desktop work computer – just don't expect it to perform better than a standard desktop machine.

GETTING YOUR HARDWARE

Want to try out a Raspberry Pi desktop for yourself? Pick up the kit you need online

Raspberry Pi Retailers

Websites that specialise in supplying Raspberry Pis offer some great deals on kits, along with the accessories you'll need. Here are some of our favourites.

Pimoroni

shop.pimoroni.com

Pimoroni is a great place to find cool Raspberry Pi kits, along with some great project ideas and accessories. They're famous for their funky Pi cases made from layers of laser-cut acrylic.

The Pi Hut

thepihut.com

The Pi Hut always has great little supplies for your Raspberry Pi projects, as well as everything you'll need for a Pi desktop.

Adafruit

adafruit.com

Looking for Raspberry Pi gear in the USA? Adafruit is one of the best sites, and has its own awesome range of components to use with your Pi.

Raspberry Pi Desktop Kits

You can build a Pi desktop yourself, or try one of these Pi PCs instead

£90/$115 to £235/$300

pi-top

pi-top.com

The pi-top is one of the first major Raspberry Pi full-computer kits, available as a pi-top laptop, or a pi-topCEED desktop. They're designed for educational purposes rather than desktop use, but they're very easy to convert once you've got everything up and running. The pi-topCEED is the cheaper model, and all you need to provide are the mouse, keyboard, and external hard drive.

£112/$110

WD PiDrive Compute Centre

magpi.cc/2s8NbZr

We reviewed this kit in issue 56, and we think it's great. It is part of the WD PiDrive series, so it comes with a case and a hard drive setup optimised for use with the Raspberry Pi. You won't need an external hard drive for this setup, and it even comes with a mouse and keyboard – all you need is a monitor!

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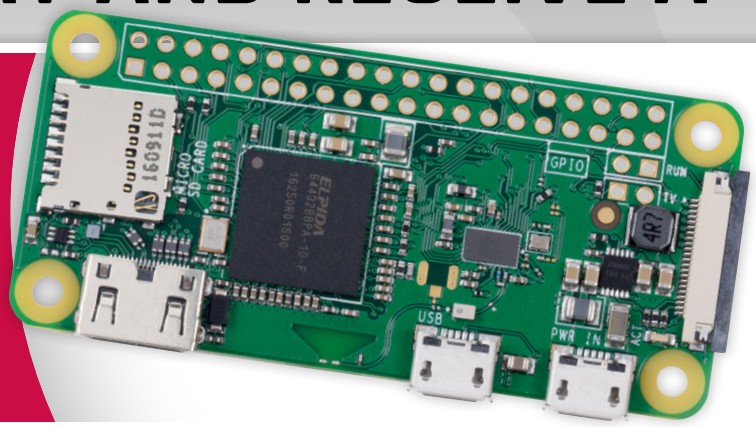

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BUILD A GPS TRACKING DEVICE
MASTER BLUETOOTH
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INGMAR STAPEL

Ingmar has been building Pi-powered robot cars since 2012. He's also working on a particulate matter sensor.
custom-build-robots.com

SATNAV FOR ROBOTS

Guide robots with incredible accuracy using this differential GPS system

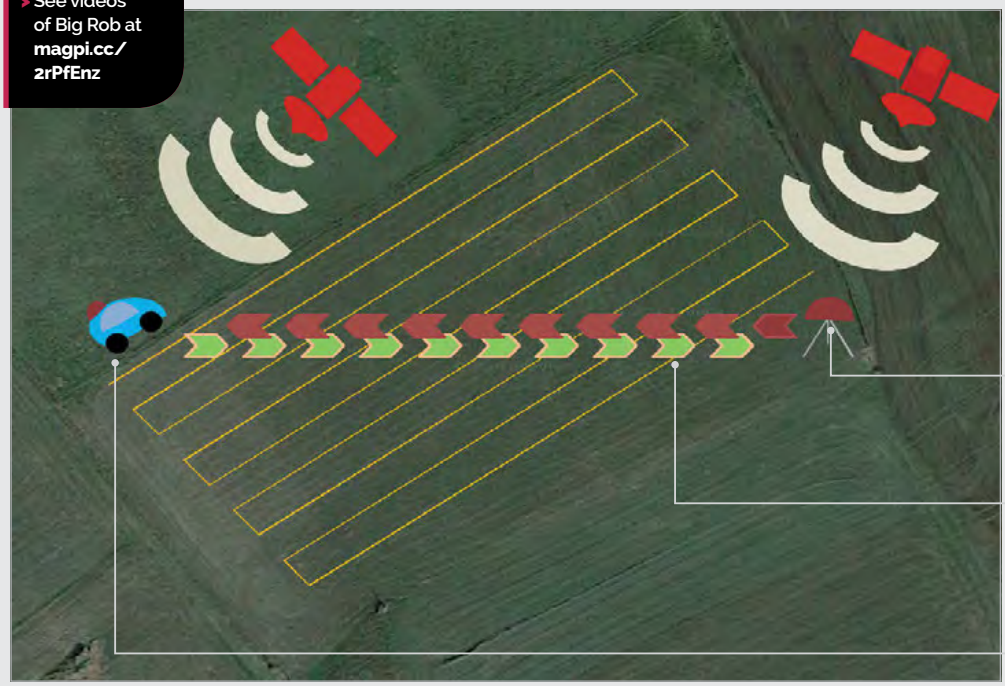
Quick Facts

- The differential GPS system is accurate to 20 cm
- The robot uses three Python programs
- €6 IKEA lunch boxes protect the base stations
- Big Rob has a 12 V 30 Ah battery
- See videos of Big Rob at **magpi.cc/2rPfEnz**

While building a rugged robot, named Big Rob, for outdoor use, Ingmar Stapel wanted to create a system for precise navigation. Disappointed with the accuracy of the standard USB GPS modules used on his previous robots, he decided to build a navigation system based on differential GPS.

Differential GPS uses the RTK (Real Time Kinematic) method for carrier-based ranging between a base station and the robot. Data sent from the base station enables the robot to correct the inaccuracies in its own GPS signal, mainly caused by atmospheric effects, in order to calculate its precise position. This technique produces an accuracy of 20 cm, compared with 4–5 m for standard GPS.

Both units are equipped with a RasPiGNSS Aldebaran module from **drfasching.com**: "It is the only one I know which is especially built for the Raspberry Pi," explains Ingmar. They are also fitted with a Tallysman GNSS antenna that can receive not just GPS signals, but also those from the Russian GLONASS system, as well as SBAS systems such as Europe's EGNOS.



The base station sends its own position to the robot to eliminate GPS inaccuracies caused by atmospheric effects

The two units are in constant communication via XBee modules or standard WiFi

The robot calculates its precise position using differential GPS, and can direct itself to various waypoints

XBee or WiFi?

To minimise GPS inaccuracies, Ingmar is using the RTKLIB Python library (**rtklib.com**) to perform the RTK calculations. "The most complex part of this project was to configure the RTKLIB library and to set up the XBee communication between the base station and the robot." The main advantage to using XBee Pro rather than standard WiFi is its superior range of up to 1.6 km. However, Ingmar has also tested the system using WiFi, which offers a higher bandwidth. Both versions of the RTKRCV program are described on his blog.

BUILD A GPS SYSTEM

>STEP-01
GPS modules
Both the robot and the base station feature a Raspberry Pi equipped with a RasPiGNSS Aldebaran module and Tallysman antenna to receive satellite signals.

>STEP-02
XBee communication
XBee Pro modules, connected to Raspberry Pis via XBee Explorer boards, are used for long-range data communication between the robot and base station units.

>STEP-03
Big Rob
Ingmar has equipped his Big Rob robot with the differential GPS system, along with a Sense HAT at the rear to aid orientation when navigating between waypoints.

Robotic navigation

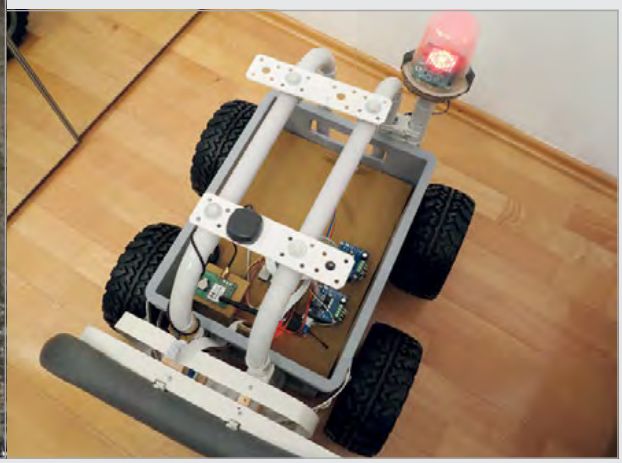
So, how does it all work in practice? Ingmar admits that it can take a while to obtain a GPS fix, depending on the surroundings and weather. "If I use the setup in open country with no clouds, the calculation of a fix position takes between 10 and 15 minutes. If I use it in the yard with high buildings around the base station and robot, it could take up to an hour to calculate only a floating GPS position."

Once it obtains a fix, the robot moves continuously from one waypoint to the next, checking its orientation with the Sense HAT magnetometer: "If a deviation of five degrees is detected to the next waypoint, the Python program corrects the speed of the DC motors to face the waypoint. Only if the GPS signal gets lost will the robot stop and wait for the next calculated fix position." Waypoints can be entered in a Terminal window or imported via a Google Earth KML file.

Ingmar has a few ideas for putting his differential GPS system to practical use. "I will mount the metal detector (as used on his Discoverer robot, featured in *The MagPi* #48) on the front of Big Rob, and together with the differential GPS setup, the robot will be able to search very precisely for metal in the ground. The next idea is to mount, for example, a lawnmower on the front or to build a fertilizer spreader. The differential GPS setup is a key feature for many ideas and setups."

Left The path of a test drive, showing the precision of the system with a floating solution from the RTK calculation

Below An early version of Big Rob showing the GPS system components, along with an illuminated Sense HAT at the rear



ALVIN GROEN

Alvin is a director, designer, and animator from The Netherlands. Currently, he lives in New York.
alvingroen.com

TELE2

How a Raspberry Pi kit helps people to live the life of a complete stranger

Quick Facts

- The Tele2 kit was used in five different countries
- The idea came from the movie *Being John Malkovich*
- 36 million people were made aware of the project
- A custom iOS app was used to control the data stream
- The equipment was in use for more than two months

We have all imagined what it would be like to be somebody else, even if just for a short time.

Tele2 is one of the more intriguing projects we've come across. It was a custom Raspberry Pi electronics kit worn by various interesting people from around the world. Each person wore a GoPro Hero 5 and Røde Video Microphone to capture a first-person view of what they were seeing and hearing.

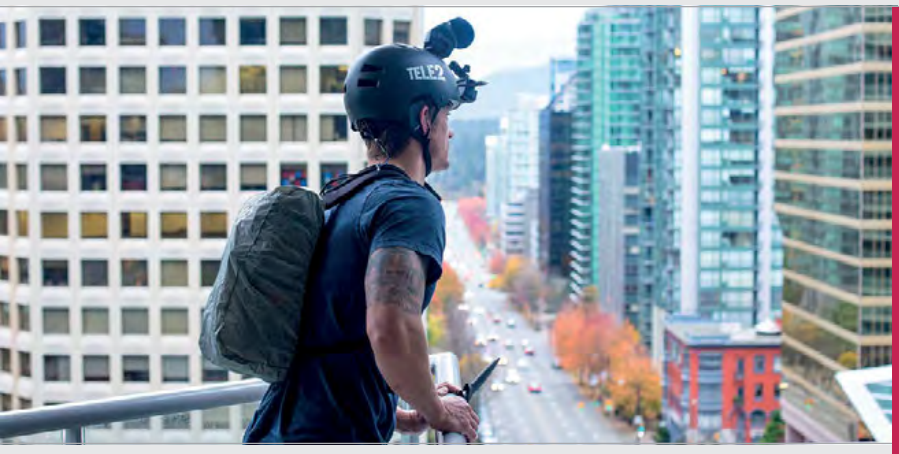
More intriguingly, the system collected data on each personality's heart rate and sweat level.

All of this data was used to measure the emotional state of the person, which was relayed to the viewers using visual effects layered on top of the audio and video. Brain sensor (EEG) data was translated into warmer or cooler video filters to represent the person's emotions.

We caught up with Alvin Groen, the director and designer of the Tele2 project, who dreamt of building a piece of equipment that "changes our perspective."

The Tele2 project is named after the Swedish telecom company that sponsored the project. "They were launching a new 100GB data plan and wanted a project that required high data bandwidth," recalls Alvin. With funding underway, the Tele2 project was born.

The Teradek VidiU enables the kit to stream live video to the web via the Tele2 modem
The Galvanic Skin Response Sensor, Polar Bluetooth HR monitor, and Muse headband all gather data on the emotional state of the wearer
An e-Health v2.0 board is mounted above a Raspberry Pi 3. The Pi collects the video and audio data, as well as the health measurements
RØDE
TERADEK
VidiU
TELE2
POLAR



Above The kit recorded everything a person saw and heard while measuring their mood levels

"In Sweden, a lot of discussion around connectivity tends to be negative," says Alvin, "especially when it comes to controlling our exposure to media."

Alvin wanted to alter the outlook people had on other lives. "Each person was chosen because they have a big following online, or they have an interesting life," explains Alvin. They included Simone Giertz, a robot maker from Stockholm, Joel Kinnaman, an actor from Vancouver (and star of the *RoboCop* reboot), and Noor Daoud, a female drift racer from Dubai. An impressive collection of folk.

> "They were launching a new 100GB data plan and wanted a project that required high data bandwidth"

Each of the personalities was hooked up to the Tele2 equipment. The team broadcasted nine live streams in five countries during a two-month world tour. "We measured the personalities' heart rate, emotions, and sweat level," using a Skin Response Sensor and Muse headband (**choosemuse.com**). Then, using WebGL and web audio technology, they translated the data live into audiovisual effects.

The team built a custom backpack using a 3D printer for each personality. The rig included a Raspberry Pi hooked up to an e-Health v2.0 board (**magpi.cc/2qnMyry**). The Raspberry Pi collected and processed all the video, audio, and sensor data.

Camera footage went to a colour grading box in the backpack. This was "fine-tuned for each location", and the video and audio was streamed live via a Teradek VidiU wireless HDMI video encoder.

The built-in wireless features of the Raspberry Pi 3 made it a good fit for the project. "The built-in Bluetooth chipset, wireless networking, and the fact that you can use a pretty standard flavour of Linux right out of the box made it very easy to work with," says Alvin.

"Since all the other equipment was rather bulky, size wasn't an issue either," he adds. "The toughest challenge was trying to figure out if we could get the Muse headband to communicate directly with the Raspberry Pi, since the official Muse SDK wasn't released for the ARM architecture."

The project was a huge success, with hundreds of thousands of people tuning in to see what it's like to be somebody else. Viewers could click on cheers and give feedback to the wearers. Overall, Tele2 was a very interesting combination of health sensors and live video streaming.

WEARABLE

>STEP-01
Build a backpack

The Raspberry Pi, e-Health shield, video adapter, wireless modem, and battery pack were carried by the wearers in a custom-built backpack.

>STEP-02
Sight and sound

The GoPro Hero 5 was mounted on the wearer's head, along with the various health sensors. Everything they looked at and heard was streamed live.

>STEP-03
World in colour

A filter was laid over the recorded video based on four mood characteristics: Angry, Happy, Sad, and Calm. This filtered video was streamed live to the web.

ERIC PAGE

Eric enjoys building things for his fiancée, Shirin, and their dog, Pickles. When he's not DIYing, you'll probably find him backpacking or running his healthcare business.
magpi.cc/2sUurv1

The cylinder is divided into sections for storage and dispensing
A stepper motor rotates the inner cylinder to dispense the treats
The Camera Module is used to detect motion and capture photos and video of the dog

DOG TREAT MACHINE

With motion detection and video capture, is this the ultimate dog treat dispenser?

Quick Facts

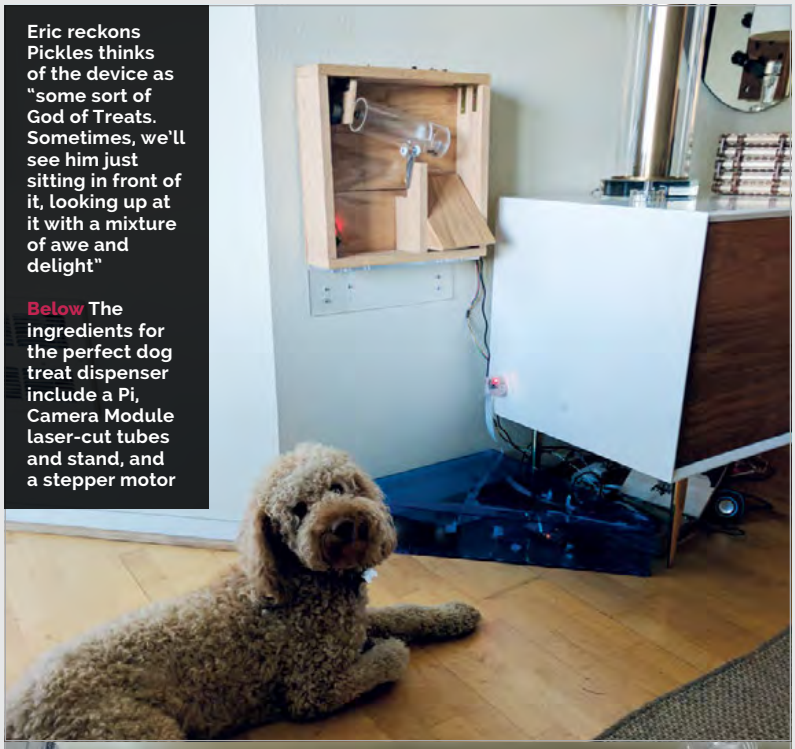
- Build details are on Instructables **magpi.cc/2sTf5qU**
- There are four ways to trigger the device
- It can dispense treats of different sizes
- Eric has added a ball launcher
- He intends to extend it further

While pondering what to get Shirin, his fiancée, for her birthday, Eric Page realised how much she misses her dog Pickles while she's at work. He decided to build a device to allow her to serve treats to Pickles remotely. "She uses it almost every day! Usually once a day when she is at her office. When she's travelling, she probably sends him three or four treats every day. I think it helps her feel closer to home."

There are four ways to trigger the Pi-powered device: email, MQTT, IFTTT, or Alexa. It then plays a sample of Shirin's voice, dispenses some dog treats, and checks for motion using OpenCV analysis of the view from a Raspberry Pi Camera Module. If motion is detected, it captures a photo and video of Pickles, which are sent to Shirin in an email with a randomised cute comment. If no motion is detected, it sends an 'I'm not home but will enjoy the treats later' message, along with a couple of photos of Pickles playing outside.

Eric says motion detection was an important addition. "I didn't want to send my girlfriend a video of a floor full of treats. Even if Pickles was home, if he walked over to the treats more quickly or slowly than expected, the video would be blank for a period of time. So I built a motion detection system using really good code from Adrian at PyImageSearch. This ensures that the video always starts with Pickles entering the area, and Shirin can see him trotting up with excitement."

Far from being a seasoned maker, Eric reveals "this was my first attempt at anything DIY in probably 25-plus years since junior high, so it took some trial and error." After starting the project with an Arduino, he soon realised that it lacked the processing power and storage required for video and other complexities. "After I switched to the Pi, it took 30-45 days to get to a version that would reliably deliver treats via email. After that, I periodically tinkered with



Eric reckons Pickles thinks of the device as "some sort of God of Treats. Sometimes, we'll see him just sitting in front of it, looking up at it with a mixture of awe and delight"

Below The ingredients for the perfect dog treat dispenser include a Pi, Camera Module laser-cut tubes and stand, and a stepper motor

it for four to five months, adding additional delivery mechanisms and improving the reliability of the code, e.g. reconnecting everything if the WiFi went down."

Eric says the most difficult part of the project was getting the device to deliver a small number of treats (not zero or too many) by gravity from its plastic cylinder, when rotated by a stepper motor. "The design went through several iterations before I hit on the concept of a cylinder with a central storage area, with an adjustable opening to a smaller section that holds and dispenses one serving."

Following the success of the treat dispenser, Eric has extended the project by building a ball launcher using RFID-tagged balls, which he's trained Pickles to retrieve and place in a receptacle equipped with an RFID reader. "Now Pickles can get his own treats by putting those balls in the receptacle. He loves it. Now, he even sits by the ball launcher making funny noises – his way of saying 'Dad, launch a ball!'."

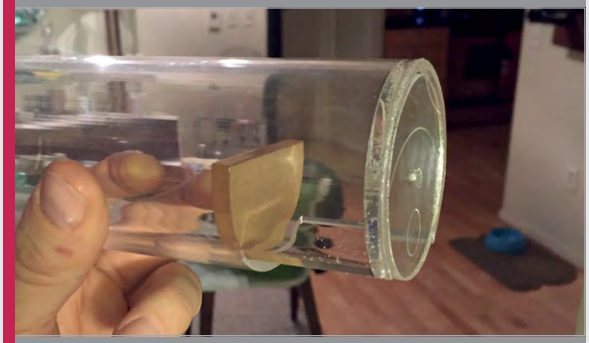
> "Now Pickles can get his own treats by putting those balls in the receptacle. He loves it"

MAKE A DOG TREAT DISPENSER

>STEP-01

Cutting the parts

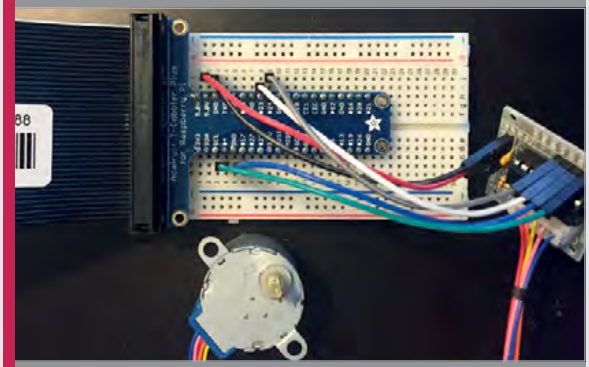
Eric used a laser cutter at a local makerspace to create the plastic stand and cylinders. The inner cylinder is divided into two compartments; one for storage and one for dispensing.



>STEP-02

Dispensing mechanism

To make sure the desired number of treats falls into the dispenser compartment, acrylic semicircles reduce the size of the opening. One of these is attached by Velcro and can be adjusted.



>STEP-03

Stepper motor

A stepper motor with driver board is used to rotate the cylinder, causing the treats to fall out of the opening, while allowing more treats to drop into the dispenser compartment.

PETER BARKER

A full-time software developer, part-time hacker, with a passion for making fun little projects to get a Pi in his pocket.

@PiOCKET / github.com/moosepr

PI0CKET-TINY PI

Possibly the world's smallest Pi-based gaming device

Quick Facts

- Tiny Pi took two months to create
- It runs for 3.5 hours on a 1000 mAh battery
- Peter is considering selling his custom PCBs...
- ...or putting together a Tiny Pi kit
- He'd like to create a Pi pocket computer

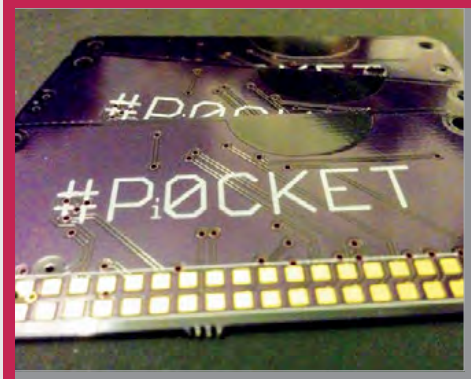
Peter Barker was inspired to start making miniature gaming devices following the release of the Pi Zero, and seeing other makers cramming it inside an old Game Boy. "After ordering all the parts, I initially wanted to do the same, but couldn't bear to take a working Game Boy apart."

Instead, he created his first standalone Pi Zero-based gaming device using a cheap 2.2 inch SPI screen flanked by two stripboard button arrays. "Things progressed from there, really," recalls Peter. "I didn't like how big the circuit board was for the screen, and realised that there weren't all that many bits to it, so I started designing my own."

This resulted in his diminutive Game Boy Zero device featuring a 2.2 inch display on a custom PCB, "which was pretty much as small as I thought I could go." However, Peter then found a smaller, 1.44 inch TFT screen that perfectly matched the 128 × 128 resolution of the Pico-8 fantasy games console (**magpi.cc/2rCswv1**) that he'd stumbled across after looking at the PocketCHIP handheld computer. "It took me back to the good old days of the [Sinclair] Spectrum, where the system was small enough that

A three-way switch can be mapped to extra functions
Tiny Pi's custom-designed PCB is just 0.8 mm thick
The 1.44 inch TFT screen's 128 × 128 resolution is a perfect match for Pico-8 games
FAVOURITES
ALONE IN PICO
SPACEMAN B 1.2
ZEPTON 0.9 BETA
PICOMAN 1.0.2
TWO HIKING CATS HAVE AN
Tiny Pi

BUILD A TINY GAMES MACHINE



>STEP-01
Make a custom PCB
To keep the size down, Peter designed his own slimline PCB and had it made by OSHPark. You can download the design or order a board at **magpi.cc/2qu0wbJ**

>STEP-02
Add a Pi Zero
The Pi Zero is mounted directly to the rear of the PCB, its GPIO header soldered to the connections. A LiPo battery and TP4056 charger are strapped in place.

>STEP-03
Make a case
Peter designed his own slimline case using OnShape. It comprises a top, bottom, and backplate, and covers for the joystick and buttons. Find the files at **magpi.cc/2qu0P6f**

kids in their bedrooms could make brilliant games. I tried it on my GBZ project and it was good fun to have a portable system that could play all these games, almost like having a part of my childhood in my pocket."

The PiOCKET-Tiny Pi (**magpi.cc/2sdhmf8**) took him two months to put together. "The biggest hold up was getting my hands on some screens. There are many suppliers who sell them attached to a PCB, but I didn't want that extra bulk." Instead, he designed his own super-skinny PCB, a mere 0.8 mm thick, which is mounted directly to the rear of a Pi Zero W.

On the front of the PCB are a five-way joystick (with push-in function) and two push buttons. There's also a three-way navigation switch at the top, which can be mapped to extra functions. The device is powered by a slimline LiPo battery, strapped to the Pi Zero along with a TP4056 charger. Stereo sound is supplied by two piezo transducers situated behind the screen.

As well as Pico-8 software, Peter has programmed the Tiny Pi to run classic console games via the RetroPie emulation system. "You are restricted on the games you can play. The 128 × 128 resolution makes things like SNES or Mega Drive games hard to see, although the Pi is actually capable of playing them."

> "As well as Pico-8 software, Peter has programmed the Tiny Pi to run classic console games"

The original version of the Tiny Pi was 'naked', but Peter has since clothed it in a 3D-printed custom case. Designed using OnShape (**onshape.com**), he's made it as slimline as possible, to match the rest of the project. "It needs a spot of refinement, but the main change I would like to make would be to the software side of things. My real goal is to have it like a Game Boy, where it starts up quickly, you can play a few games, then just switch it off, no worries about shutting down and waiting for it to finish things."

Above You can get an idea of just how tiny the Tiny Pi is when it's placed next to a Nintendo Game Boy
Above top With RetroPie installed, the Tiny Pi can emulate classic games machines such as the Sega Game Gear

CODE WITH THE SENSE HAT EMULATOR

Practise coding for the Sense HAT hardware using the Sense HAT emulator built into Raspbian

You'll Need

- Raspberry Pi
- Raspbian
- Sense HAT emulator

The Sense HAT is one of the most important pieces of Raspberry Pi hardware. The board was developed to travel aboard the International Space Station (ISS) as part of the Astro Pi mission. It was also made available to buy, and schoolkids around the world use it to develop code – some of which runs in space as part of a series of competitions.

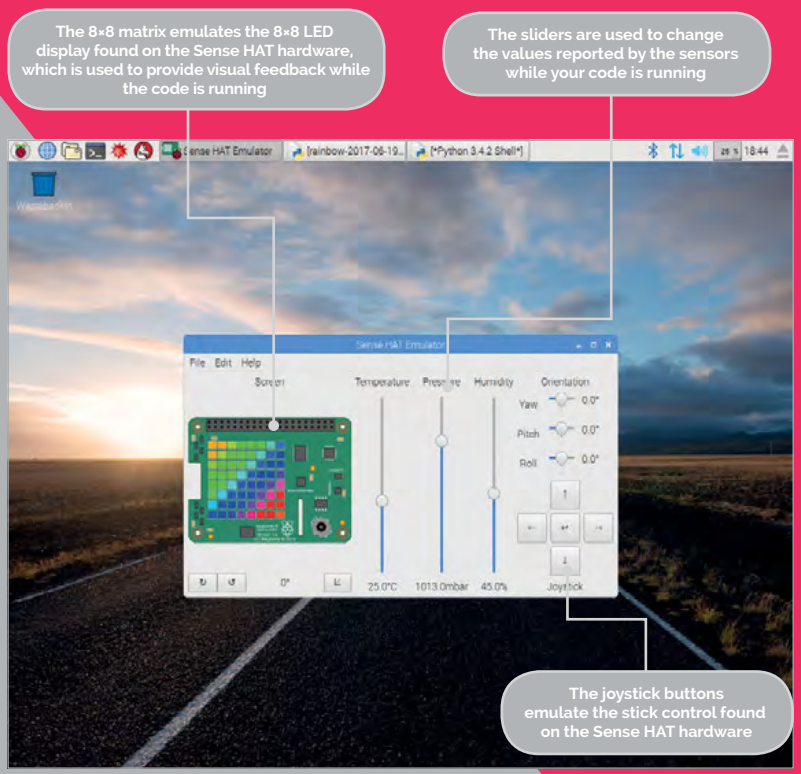
The Sense HAT adds various sensors to the Raspberry Pi: gyroscope, accelerometer, magnetometer, temperature, barometric pressure, and humidity.

The Sense HAT emulator was developed by Dave Jones (**github.com/waveform80**). It is intended for people who own a Raspberry Pi, but not a Sense HAT.

You develop code for the Sense HAT and run it in the emulator. A visual representation of the Sense HAT hardware appears, and a range of sliders and buttons can be used to emulate the Sense HAT's features.

The sliders are used to change the values reported by the sensors while your code is running. You can increase the pressure and humidity that the Sense HAT hardware would detect, and check that your system responds accordingly.

The Sense HAT emulator is a great option for somebody who wants to develop code for the Astro Pi mission, but doesn't have access to the Sense HAT hardware. It's also a great environment for testing code, because you can manually adjust the values reported via the sensors.

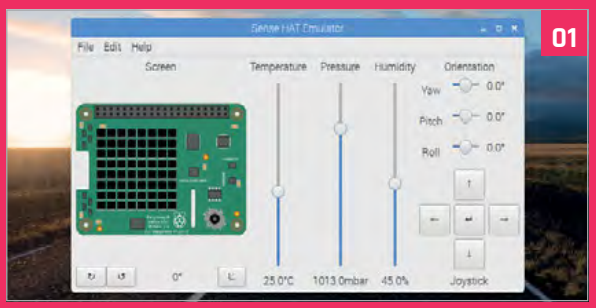

The 8×8 matrix emulates the 8×8 LED display found on the Sense HAT hardware, which is used to provide visual feedback while the code is running
The sliders are used to change the values reported by the sensors while your code is running
The joystick buttons emulate the stick control found on the Sense HAT hardware

HOW TO: START USING THE SENSE HAT EMULATOR

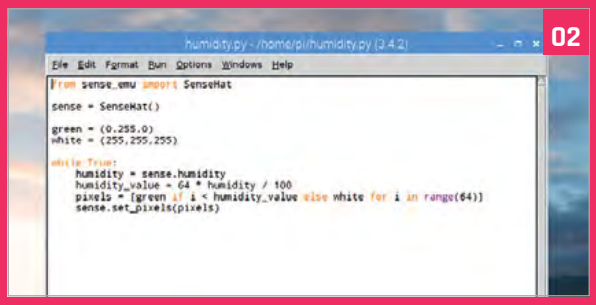
>STEP-01

Start up

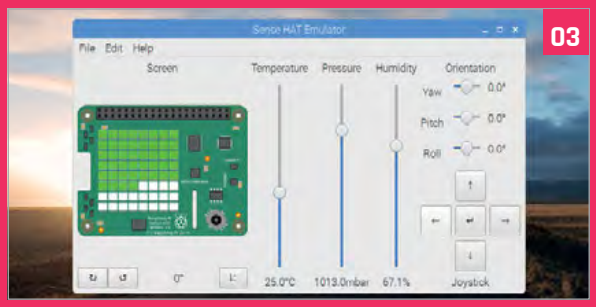
You can access the Sense HAT emulator from the Raspbian desktop menu, under Programming. The emulator closely simulates the experience of attaching the Sense HAT hardware to your Pi. You can read from the sensors or write to the LED matrix using multiple Python processes.



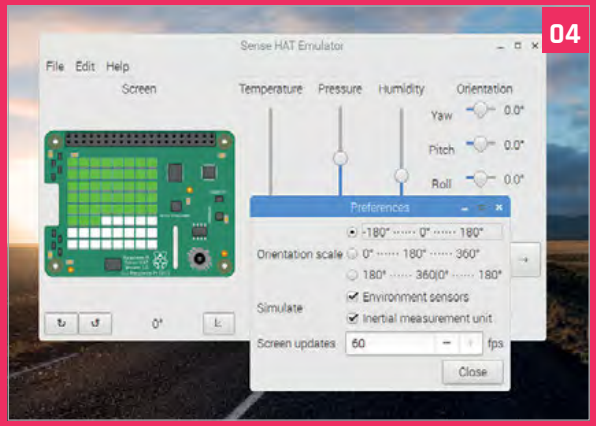
>STEP-02
Code
Open IDLE (Programming > Python 3) and choose File > New. Enter the code from **humidity.py**. This program adjusts the number of green and white pixels displayed on the LED, depending on the detected humidity.



>STEP-03
Run and adjust
Run the program in IDLE (Run > Run Module) and the Sense HAT image will appear and display some green LEDs. Adjust the humidity slider and watch the number of green LEDs change to match the new readings.



>STEP-04
Preferences
There are some preferences that you can adjust to change the behaviour of the emulator. Choose Edit > Preferences. Increase the Screen updates value to provide a more realistic experience of the behaviour of the hardware sensors. You'll see that the values being returned in your code drift according to the known error tolerances of the physical sensors used on the Sense HAT.



humidity.py

Language
>PYTHON

```
from sense_emu import SenseHat

sense = SenseHat()

green = (0,255,0)
white = (255,255,255)

while True:
    humidity = sense.humidity
    humidity_value = 64 * humidity / 100
    pixels = [green if i < humidity_value
                        else white for i in range(64)]
    sense.set_pixels(pixels)
```

>STEP-05
Code examples
If you're new to the Sense HAT, you can copy and paste a range of example code from the Raspberry Pi educational resources page. Projects include a getting started guide (**magpi.cc/2rvSPSB**) and a random number program (**magpi.cc/2rvpOXq**). You will also find lots of examples under File > Open Example. These will be written to your home directory.

>STEP-06
Port to Sense HAT
If you want to port your emulator code to a physical Sense HAT, you just need to change:

`sense_emu`

to...

`sense_hat`

Reverse this if you're porting a physical Sense HAT program to the emulator, perhaps from one of the online educational resources.

Sense HAT Essentials

If you're interested in learning more about the Sense HAT, check out our Sense HAT Essentials guide, *Experiment with the Sense HAT*.

magpi.cc/Sense-HAT-book

CLONE, COPY & CONTRIBUTE TO CODE WITH GIT

Use Git version control software to work on your own code and contribute to open-source projects. By **Marc Scott**

You'll Need

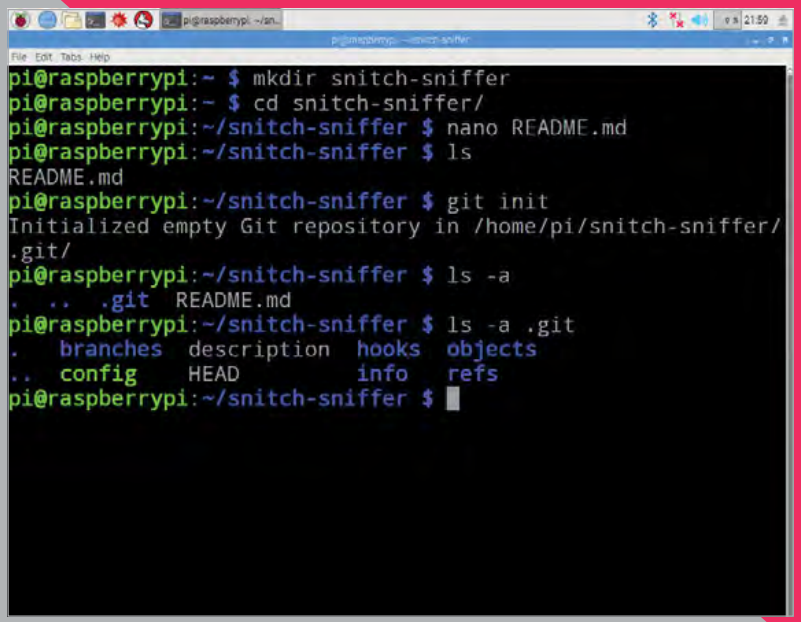
- Raspberry Pi
- Raspbian
- Git

Git is powerful software that lets you clone, copy, and contribute to code projects. Discover how to master Git and you'll be a much better project maker.

If you're working on a Raspberry Pi, then congratulations: Git already is installed in Raspbian by default! If you are on another Linux build, or ever need to install Git on another Linux system, this is all you need:

```
sudo apt install git
```

You're going to be working in a Terminal window for this tutorial, so open it by clicking on the icon on the desktop, or by pressing **CTRL+ALT+T** on the keyboard.



Initialising a directory of code (and other files) adds a hidden .git directory to it; this directory is used to track changes

The first thing to do is to tell Git who you are. This is important, as Git can be used collaboratively by lots of people, so it needs to know who made changes to which files. Use your user name and email address.

```
git config --global user.name "Harry Potter"

git config --global user.email "h.potter@hogwarts.prof"
```

Next, you need to tell Git which text editor you want to use. If you don't have any particularly strong feelings about text editors, then type:

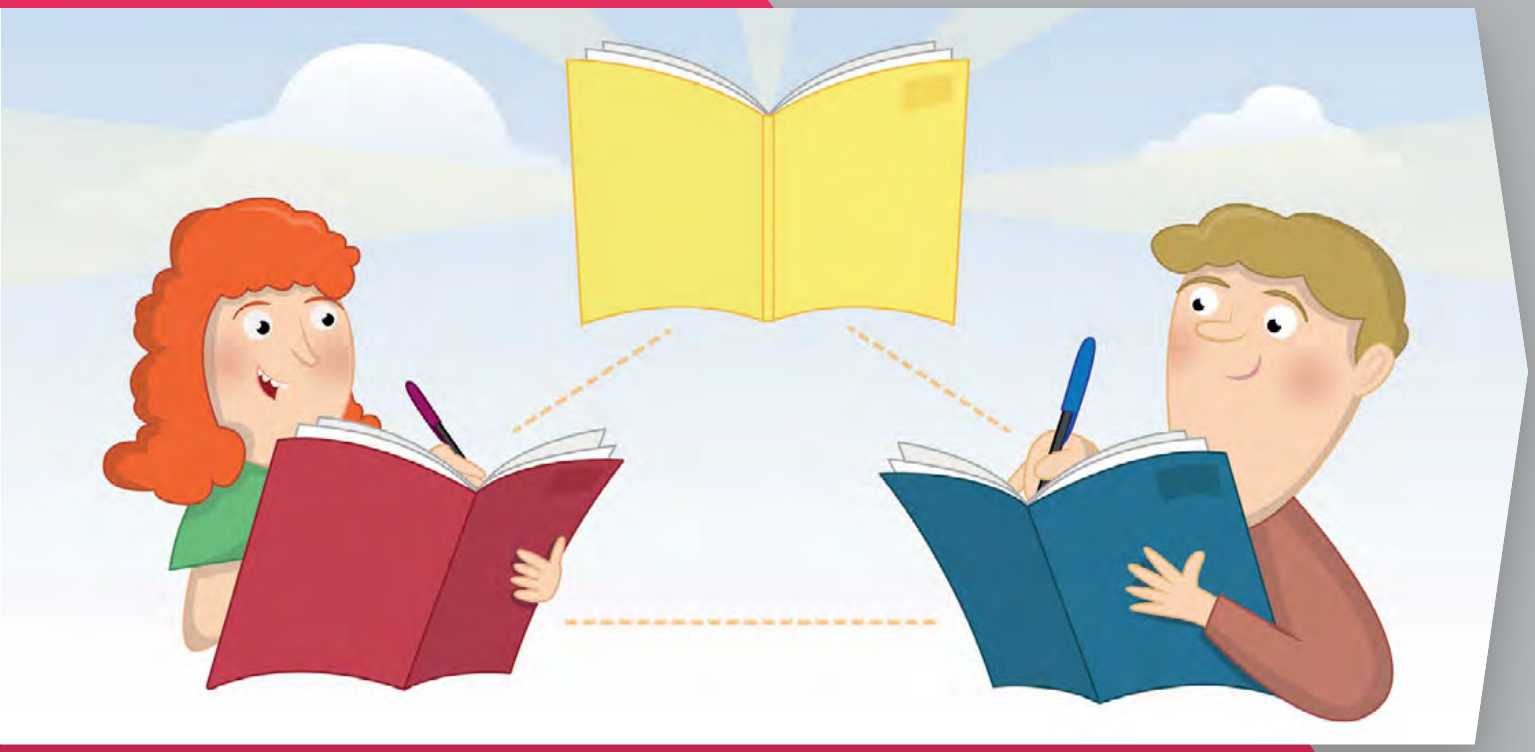
```
git config --global core.editor nano
```

Now you are ready to start using Git to manage your projects.

The magical briefcase

One way to think about Git is to imagine a magical briefcase. You can pull documents out of the briefcase and work on them whenever you like. Once you've finished your work, you can put the documents back into the briefcase, and the case remembers what changes you made to all the documents inside.

What's really clever is that this briefcase can be synchronised with another master briefcase that lives in the clouds. Whenever you like, you can tell your briefcase to copy the contents of all the documents to the master briefcase. If you lose your own briefcase, you don't have to worry, as you can



just get a new one and grab all the documents and writing from the master briefcase.

That's not all, though. The other people working on your project also have magical briefcases, and they also keep their documents synchronised with the master briefcase. This means that you can all work on a project together. If someone else has a better answer to a project question than you do, you can copy their answer from the master briefcase to your document.

Start a project

So you want to start a new project? Maybe it's a special ultrasonic range finder for tracking flying objects in the air. You'll want a directory on your computer for all your files to sit in, so the first thing to do is create that directory.

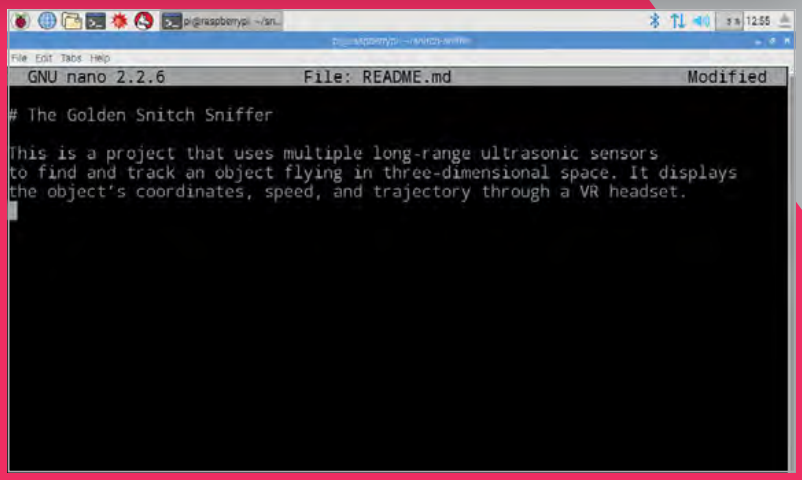
In the Terminal, you can use the **mkdir** (make directory) command to create a new directory.

```
mkdir snitch-sniffer
```

Now you want to go into that directory. You can use the **cd** (change directory) command to do this.

```
cd snitch-sniffer
```

Next, you can create a file that will tell people what the project is about. You can use any text editor to do this, but in this example, nano is used to create a file called **README.md**. The .md extension stands for Markdown, which is a markup language. You can learn more about Markdown on the Daring Fireball website (**magpi.cc/2scx1iu**).


GNU nano 2.2.6
File: README.md
Modified
The Golden Snitch Sniffer
This is a project that uses multiple long-range ultrasonic sensors
to find and track an object flying in three-dimensional space. It displays
the object's coordinates, speed, and trajectory through a VR headset.

Use nano to edit the README.md text file

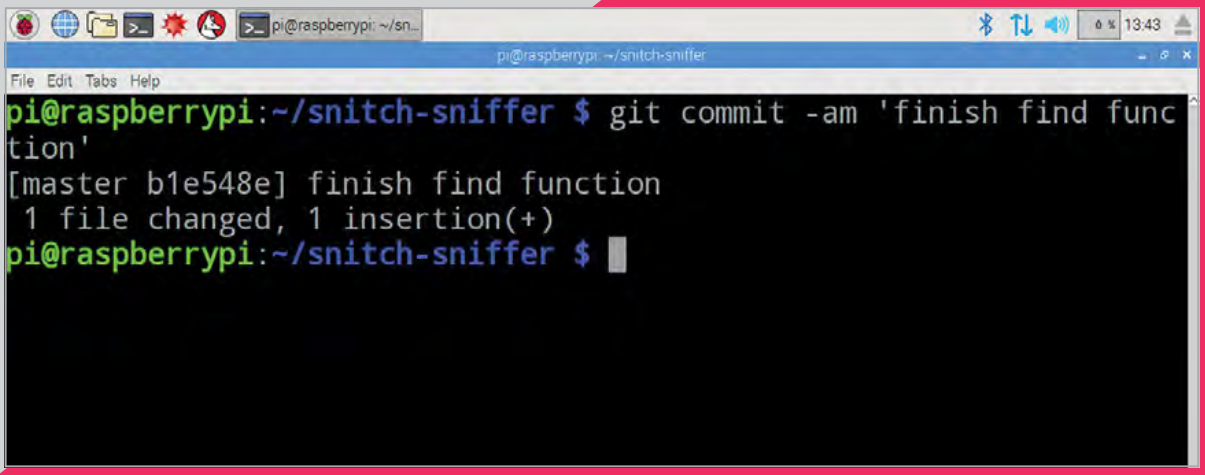
```
nano README.md
```

This command opens up the file in the Terminal. You can now give the file a title and write a short explanation of what your project is about.

```
# The Golden Snitch Sniffer

This is a project that uses multiple long-
range ultrasonic sensors to find and track
an object flying in three-dimensional space.
It displays the object's coordinates,
speed, and trajectory through a VR headset.
```

Pressing **CTRL+X** will cause a save prompt to appear. You can type **Y** to save and then hit **ENTER** to close nano. Your file should have been created and will now be sitting in your directory. You can type **ls** in the Terminal to see a list of files.

Perform a new commit every time you make a change to your file



Create the magic briefcase

At the moment, the directory is just like any other directory on your system. You now need to make the magical briefcase part. This is known as a Git repository, and it takes the form of a hidden directory that keeps track of all the changes to the working directory. Type the following:

```
git init
```

This creates the repository, which from now on will just be called a repo.

If you type **ls** again, nothing will appear to have changed. You can use **ls -a** to see all the hidden files and directories, though.

You should now see something like this in your Terminal window:

```
.  ..  .git  README.md
```

That .git directory is the repo skeleton. You can have a look inside it by typing **ls -a .git**.

This should bring up something like:

```
branches config description HEAD hooks
info objects refs
```

You don't need to worry about this directory at all now. Just know that it is there and that it's tracking all the changes to the parent directory **snitch-sniffer**.

Add your books

So you now have the magic briefcase, but you haven't yet added anything to it. That **README.md** file hasn't been placed into the briefcase yet. You need to tell Git that you want to add the **README.md** file to the repo. To do this, type:

```
git add README.md
```

Sometimes it's easier to just add everything to the repo, though, rather than adding individual files. To do this, you type:

```
git add --all
```

Now Git knows that it needs to keep track of all the changes that happen to the **README.md** file. You can have a look at the status of your repo at any time by typing:

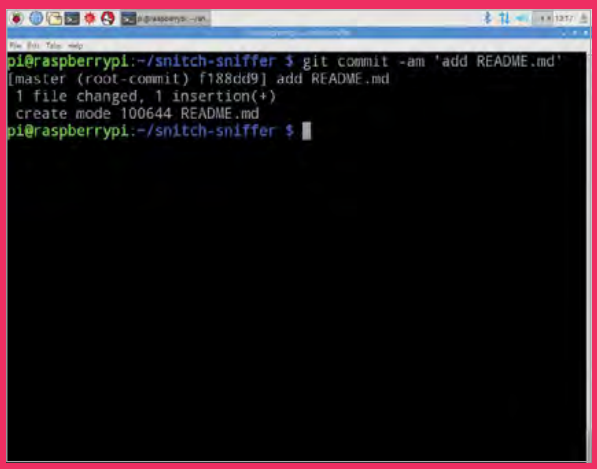
```
git status
```

You should see something like this:

```
On branch master

Initial commit

Changes to be committed:
  (use "git rm --cached <file>..." to unstage)

        new file:   README.md
```

This is telling you that the **README.md** file has not yet been committed. This means that although Git knows about the file, it doesn't yet have any of the file's contents stored. The simplest way to do a commit is by typing:

```
git commit -am 'add README.md'
```


pi@raspberrypi:~/snitch-sniffer $ git commit -am 'add README.md'
[master (root-commit) f188dd9] add README.md
1 file changed, 1 insertion(+)
create mode 100644 README.md
pi@raspberrypi:~/snitch-sniffer $

Add files to the Git repo and commit the changes with a comment

This commits all the changes you have made in the directory to the Git repo, and adds a message saying what you did. The message can be anything really, but it's best to keep it fairly short yet descriptive of what you changed.

Time travel

Now that you have set up your repo, it's time to get on with the project. Create two new files and store them in your **snitch-sniffer** directory:

```
touch snitch-sniffer.py quidditch-rules.json
```

Typing **ls** reveals those files.

```
README.md  quidditch-rules.json  snitch-
sniffer.py
```

The new files need to be added to the Git repo and then committed.

```
git add --all

git commit -am 'add json rules and python
program'
```

Carry on working on your code (enter **nano snitch-sniffer.py** and add some dummy code). Every time you make a change to the file, perform a new commit.

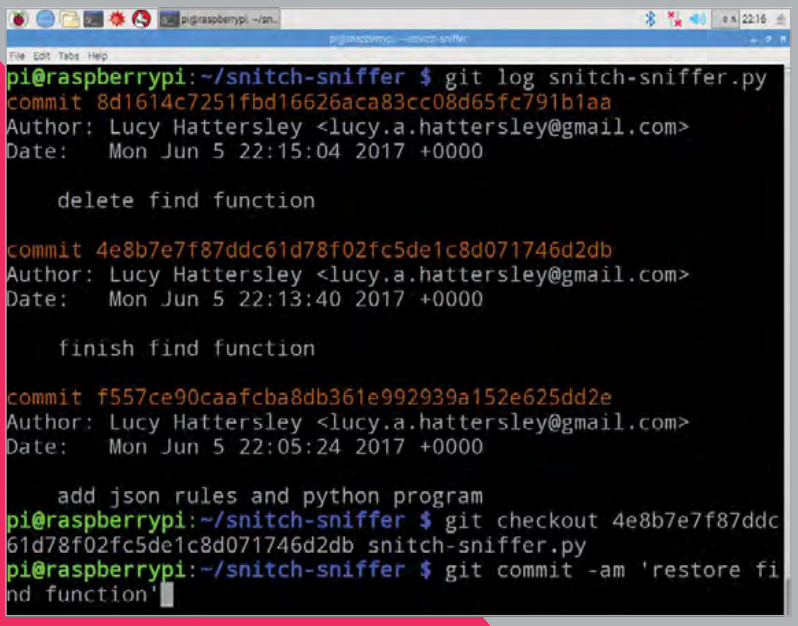
```
git commit -am 'finish find function'
```

Now imagine that you've made a horrible mistake. You've been working for a while, and you've deleted your **find_snitch()** function, and then performed a commit. With Git, it's easy to go back in time and restore an earlier version of any of your files. Let's first look at the commit history of the file.

```
git log snitch-sniffer.py
```

This produces something like this:

```
commit
12c4c693e95438ceadcf3f4fb39c83ce1ade712f
Author: Harry Potter <h.potter@hogwarts.prog>
Date:   Fri Mar 3 20:27:17 2017 +0000

    delete find function

commit
5fd772a292c019a7cf3012b1156685280d4a7d2d
Author: Harry Potter <h.potter@hogwarts.prog>
Date:   Fri Mar 3 20:24:52 2017 +0000

    finish find function
```



A great thing about Git is that it tracks changes so that you can restore an earlier version of your code at any time

```
commit
127545c19794b5fe869dd22d0cf57bf8820c5794
Author: Harry Potter <h.potter@hogwarts.prog>
Date:   Fri Mar 3 20:20:18 2017 +0000

    add json rules and python program
```

You can see that the last commit (the one at the top) was where the function was deleted. Luckily, the commit message has made it easy to see what was done, which is why commit messages are important. However, typing:

```
git log -p snitch-sniffer.py
```

…would have shown the changed contents of the file if the commit message wasn't clear enough.

You can now get back the version of the file from the previous commit. The long string of characters after the word 'commit' is called a hash, and is used by Git to keep track of files. In this case, the commit that needs to be restored is **5fd772a292c019a7cf3012b1156685280d4a7d2d**. Typing the following will get the file back to the way it was:

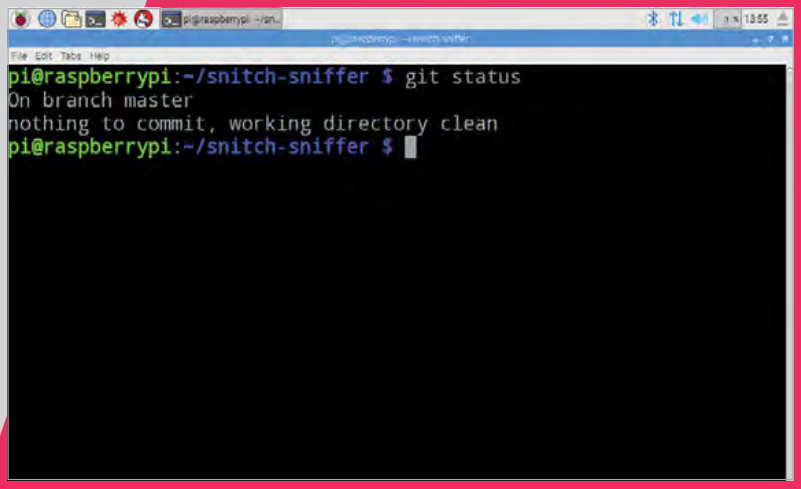
```
git checkout
5fd772a292c019a7cf3012b1156685280d4a7d2d
snitch-sniffer.py
```

The file will be restored, and you can now commit this change.

```
git commit -am 'restore find function'
```

Making major changes

Imagine you're talking to someone about your amazing project, and they have a cool idea for some



You can always check the current status of your repo

changes you could make to improve it. They suggest using lidar rather than ultrasonic sensors. The changes are quite large, though, and you're worried that if you make them, you might break the project.

You could make a copy of the directory and start working on this copy, but to keep using Git, you'd have to make an entirely new repo. This could all get quite confusing. Luckily, Git has a feature called branches. Using a branch allows you to make copies without losing or altering your original work.

First, you can have a look at your repo's current status.

```
git status
```

This should show something like this:

```
On branch master
nothing to commit, working directory clean
```

Now you can make a new branch in the repo, which lets you work on your amazing new adaptation.

```
git checkout -b lidar-version
```

Now **git status** will show you something like this:

```
On branch lidar-version

nothing to commit, working directory clean
```

This tells you that you are on the lidar-version branch. To view all the branches in your repo, you can type **git branch**, which will show something like this:

```
* lidar-version
  master
```

You can now work on the lidar-version branch without altering your master branch. If you try out the new approach and find it doesn't work, you can simply delete the branch using **git branch -D lidar-version**.

However, if it all works well, you can merge the branch back into your master branch. First, you'll need to make sure all your changes are committed and then switch back to the master branch.

```
git checkout master
```

Then you can merge the version into the master branch:

```
git merge lidar-version
```

Warning: you can cause problems with a merge if you're working on two branches at the same time, as Git won't know which changes are the ones you want to keep. For this reason, it's best to work on one branch at a time.

Setting up a Git service

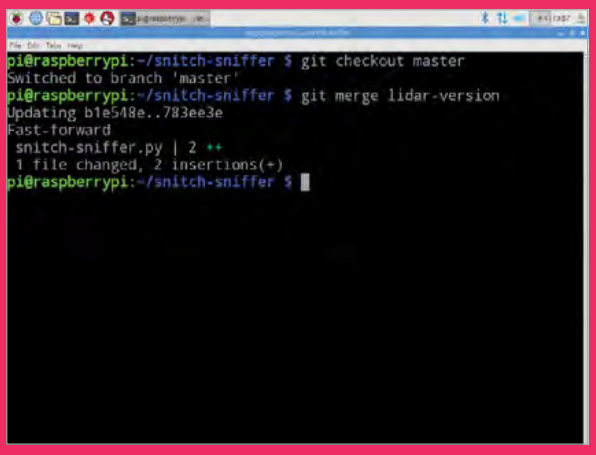
Now that you know how to do the basics in Git, it is time to learn how to use it to its full potential: sharing your work and collaborating with others.

There are lots of services that will host your Git repo for you, free of charge. GitLab is one such service, and BitBucket is another. In this resource, you are going to be using GitHub (**github.com**), which is one of the more popular services.

The first thing to do is to register for an account on GitHub: just choose the free plan. Now that you have an account, you can create a **snitch-sniffer** repo on GitHub. Click the New Repository button to the right of Your Repositories. Give the repo a name (enter **snitch-sniffer** in the Repository Name field, and a short description, such as '3D tracking of objects in space' and click Create Repository). This will bring up a page of instructions. As you already have a repo ready to push to GitHub, all you need to do is make sure you are in your project directory in a Terminal window, and type:

```
git remote add origin https://github.com/
harrypotter/scratch-sniffer.git
```

...and then:



Merging puts the changes you have made into your master branch

Use the GitHub website to create a repository (repo)

```
git push -u origin master
```

You will need to enter **yes** in the command line to accept the authentication token, then your GitHub user name and password. If you look on GitHub, you should now be able to see your repo, along with the displayed **README.md** file that you wrote.

Any time you make changes to your project, and you want to push them up to GitHub, you can just type:

```
git push origin master
```

You may see an RSA fingerprint warning. Enter **yes**. If you are working on a different branch, you would type:

```
git push origin <branch-name>
```

Collaborative working

The true power of services like GitHub becomes apparent when you start working with other people. GitHub allows other people to make their own copies of your projects, or you to make copies of theirs. Either of you can then make improvements to the project and then push the improvements up to GitHub for everyone to share.

This tutorial started as a GitHub repo. You can find it at **magpi.cc/2rM1cow**. That means that if you found a mistake in the resource, or if you just wanted to make some improvements, you can. There are two main ways to get involved with other people's projects: issues and pull requests.

GitHub issues

The copy editors at Raspberry Pi are pretty amazing, so the chances of you spotting a typo in this tutorial are pretty slim. You might spot a mistake in some of the code, though, and that's where you can help out. Take this bit of code for example:

```
print('Hello World!)
```

Let's see how you could help fix this error. Head on over to **magpi.cc/2rM1cow**, and make sure you are logged in. Find the Issues tab. You can now create a new issue, and give a description. Once that's completed, the maintainers of the repo will be able to reply to you, and close the issue once it's fixed.

Pull requests

Issues are great, but if you want to help out even more, the project maintainers are usually very happy for you to fix or improve projects yourself. To do this, you need to make your own copy of the repo so that you can work on it.

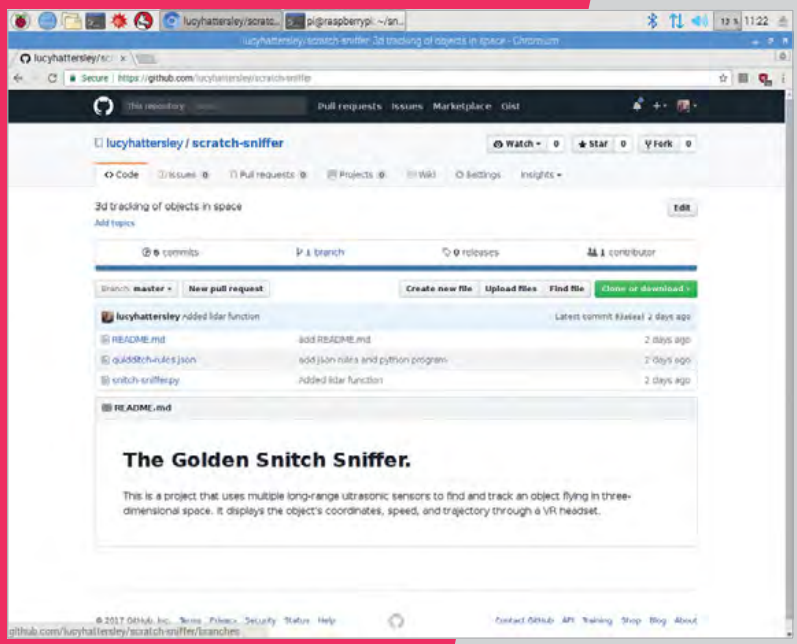
On the project's main page, find the Fork button and click it. You will now have a copy of the repo. You should see a Clone or Download button. Clicking this will reveal the uniform resource identifier (URI) of the repo. Using the Terminal, you can clone the repo to your computer with **git clone**:

```
git clone https://github.com/HelpfulUser/
getting-started-with-git.git
```

All the files and directories will now be on your computer. Go ahead and make the changes you want, then commit them and push them back up to GitHub, just as you would normally do. Here your commit message is particularly important, as it will explain to the resource's original owner the changes you have made.

You can now head back over to GitHub. Find the button that says New Pull Request. Click the button and then click on the Create Pull Request button. Your commit message will be there, but you can change it and even add a more detailed description if you like.

Once you're happy, click the Create Pull Request button. The maintainer of the repo will then be able to see your pull request. They can then choose to merge it into their repo or close it.


lucyhattersley / scratch-sniffer
3d tracking of objects in space
The Golden Snitch Sniffer.
This is a project that uses multiple long-range ultrasonic sensors to find and track an object flying in three-dimensional space. It displays the object's coordinates, speed, and trajectory through a VR headset.

The snitch-sniffer repo, showing branches, commits, and other information

BILL BALLARD

Bill is a retired physicist who went back to his programming roots and found fun things to do with his ten Raspberry Pis, even while sailing.
github.com/wpballa

SAILING PI

Track and map your sailing adventure, wherever you go

You'll Need

- Raspberry Pi Zero W with case and GPIO header
- Ultimate GPS breakout **magpi.cc/2qLDUpB**
- Pimoroni Scroll pHAT **magpi.cc/2qMVMks**
- 40-pin stacking header for the Scroll pHAT
- USB to micro USB cable for power
- 12 V USB power adapter suitable for a car

My weekly sailing crew asked for a way to visualise where we had been, and for a live display of the true speed over ground to see whether we were fighting tides. This project delivers both, without relying on internet connections or cell phone data. Add a battery and it would also be useful for car rallies or cyclists. All you need is a Raspberry Pi Zero W with some additional hardware, Python, and Mathematica!

Assembly

Solder the dual male header to the Raspberry Pi Zero W, and solder the stacking header to the Scroll pHAT. Cut off the header wires except for pins 4, 6, 8, and 10 (see **magpi.cc/2sApUOQ**). Double-check the pin numbering before you do this! Bend these four pins through 90 degrees so that they point outwards.

Take four wires of different colours, about 10 cm long, and solder them into the GPS breakout Vin, GND, TX, and RX connectors, bringing the wires in from the top of the board. Next, solder the Vin wire to pin 4 of the GPIO, GND wire to pin 6, RX wire to pin 8, and TX wire to pin 10. There should be no crossover wires.

Software setup

Boot up your Raspberry Pi Zero without the GPS attached. Go to Preferences > Raspberry Pi Configuration. In the Interfaces tab, be sure to enable SSH, Serial, and I²C. In the System tab, you will also ensure the Boot option is 'To CLI' (command line interface). Next, set up the wireless and reboot.

Now load some special software for the Scroll pHAT and the GPS:

```
sudo apt-get install python-scrollphat gpsd
gpsd-clients python-gps
```

The GPS uses the TX/RX pins that are the console defaults, so you need to make some modifications to the system:

SCROLL pHAT
PIMORONI.COM
The Scroll pHAT entirely covers the Raspberry Pi. Note the GPIO connections
Note the four connecting wires with twists to make sure the antenna points upwards

SPEED UP GPS ACQUISITION

Installing the optional battery on the GPS board will significantly speed up satellite acquisition when starting the system

```
sudo nano /boot/cmdline.txt
```

Remove the **console=serial0,115200** portion of the line. Then save the file and exit the editor.

```
sudo systemctl stop serial-getty@AMA0.service
sudo systemctl disable serial-getty@AMA0.
service
sudo halt
```

When the system stops, remove the power and install the scroll pHAT with the GPS breakout. Power the system up. The Fix light on the GPS board will blink once every second with no satellite fix, and every 15 seconds with a fix. If you don't have a fix, move the system to a window with a good view of the southern sky (northern sky in the southern hemisphere) where the antenna can see the satellites.

While you are acquiring a lock, we need to disable the standard gpsd socket. In a Terminal window, type:

```
sudo systemctl stop gpsd.socket
sudo systemctl disable gpsd.socket
```

Program

Download the Python program **gpsd-boat.py** and Mathematica notebook **LatLonPlot.nb** from **magpi.cc/2qN6BmG**. The system will not have a live internet connection while you are sailing, and so it will not know the date straight away. As a result, the program waits for the GPS to get a fix and uses the UTC date information to generate file names with the current sailing date. Automate everything so that the program starts at boot time:

```
sudo nano /etc/rc.local
```

Add the following two lines to the file just before the **exit 0** line:

```
gpsd /dev/ttyS0 -F /var/run/gpsd.socket
python /home/pi/gpsd-boat.py > /home/pi/
gpsd-boat.log 2> /home/pi/gpsd-boat.err &
```

Then save and exit. The last line will start the Python program as a background job, redirect output to a log file, and redirect any error messages to an error file for later debugging.

We are sailing

Now go sailing, or perhaps driving. A 12 V automotive USB plug works in a car or in the boat, in one of the many 12 V outlets. Above deck these are likely to be corroded, so be prepared to clean the contacts (Scotch Brite scouring pads work well), and keep the Raspberry Pi and GPS in a plastic bag to ward off water. Power everything up and go for a sail. When you've finished sailing, unplug the system and take it home.

Language

>PYTHON AND MATHEMATICA

FILE NAMES:
gpsd-boat.py
LatLonPlot.nb

DOWNLOAD:
magpi.cc/2qN6BmG

Above The unit installed on the boat's instrumentation console

When you get home and have internet access again, connect the Raspberry Pi to a monitor and keyboard. The CSV output file is designed to be easily read with Mathematica. However, because we crashed the Pi to power it off on the boat, you will need to edit the file with nano and remove the last line or two, which will contain some garbage. If the application crashed and restarted at any point, there will be extra headers you should search for and delete. These files were written as root, so, where 2017-05-04 is replaced by your activity date:

```
sudo nano 2017-05-04-latlon.csv
```

Remove the last few lines and any errant blank lines or additional headers. Then save the file and exit.

Start Mathematica and use the **LatLonPlot.nb** notebook you downloaded to visualise your sail, but replace the date with the date identifier for your file. The first line of the file imports the data from the comma-delimited file and loads the header and data separately. The output of this command should be a partial list of all the latitude and longitude pairs. The second line converts the latitude-longitude data into a **GeoPosition** set of variables, and then a **GeoPath** construct for plotting. The output of this should be a small graph of the path taken, but with no map. The third line places the **GeoPath** on an automatically sized map and places the output in the file **image.jpeg**. **PlotStyle** controls the colour and thickness of the sailing path plot.

Hit **SHIFT+ENTER** to force an evaluation and wait a while (the header will show running), particularly if it was a long sail. It takes quite some time for Mathematica to load the map data over the internet, so be patient. When the calculation is complete, open the **image.jpeg** file to have a look.

MOUNTING THE UNIT

The final product is held in place with Velcro strips on the back of the Pi and on the boat console

MARTIN O'HANLON

Martin is the creator of Blue Dot, co-author of *Adventures in Minecraft*, and a Picademy trainer. **stuffaboutco.de**

BLUE DOT BLUETOOTH

Remove the wires from your Raspberry Pi with the Blue Dot app

You'll Need

- Android phone or tablet
- Raspberry Pi with Bluetooth
- Blue Dot **magpi.cc/2qRf8EO**

Adding Bluetooth control to your projects has never been easier, thanks to Blue Dot's app and simple-to-use Python library. The app's simple blue circle can be pressed and released like a button, pushed like a joystick, and swiped like a touchscreen.

In this walkthrough we will set up Blue Dot and use the remote app (on an Android device or a second Raspberry Pi) with the bluedot Python library to make lights turn on, create a DJ scratch machine, and add Bluetooth control to a robot. Blue Dot makes using Bluetooth simple, so you are only limited by your imagination!

Left The Blue Dot app is available for Android and Raspberry Pi

The first step is to install the bluedot Python library on your Raspberry Pi, so you can interact with the remote app. Click Menu > Accessories > Terminal and enter the following:

```
sudo apt-get install python3-dbus
sudo pip3 install bluedot
```

The Blue Dot app for Android can be installed from the Google Play Store (**magpi.cc/2q8wkTq**).

If you are using a second Raspberry Pi as your remote, you should install the bluedot Python library on this as well.

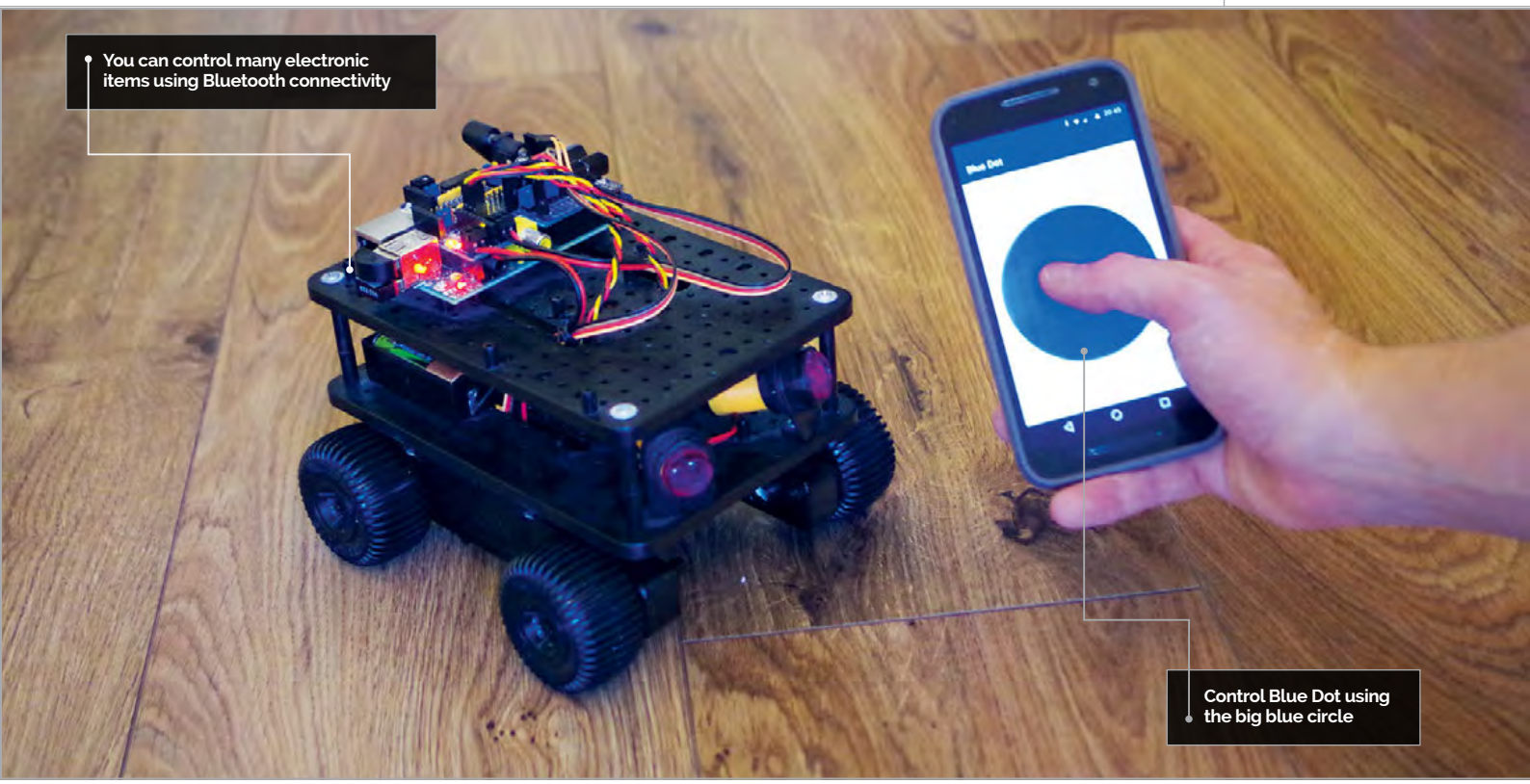
Pair the device

We need to pair the remote device running the Blue Dot app (the Android device or the second Raspberry Pi) with the first Raspberry Pi, so they can communicate.

If you are using an Android device, open Settings and select Bluetooth to make the device discoverable.

If you are using a second Raspberry Pi device, click the Bluetooth icon and select Make Discoverable. Now, on your first Raspberry Pi, click the Bluetooth icon on the taskbar, select Make Discoverable, and click Add Device.

When your remote device appears, select Pair and follow the instructions. There are step-by-step installation and pairing instructions in the Blue Dot getting started guide at **magpi.cc/2q9cwiq**.



Hello world

Now that Blue Dot is installed and paired, you can write your first Bluetooth program. It's a classic: when the dot is pressed, 'Hello World' will be printed to the screen.

Open Python 3, click Menu > Programming > Python 3 (IDLE). Click File > New File to create a new program. Create your Python program:

```
from bluedot import BlueDot
bd = BlueDot()
bd.wait_for_press()
print("Hello World")
```

Save your program: click File > Save As and save as **mydot.py**. To run the program, click Run > Run Module or press **F5**.

Start up the remote

Now it is time to start up the remote. On Android, open the Blue Dot app. If you are using a second Raspberry Pi, open a Terminal and run:

```
python3 -m bluedot.app
```

Select your first Raspberry Pi from the list of paired devices and press the dot. You can set functions to be called when the blue dot is pressed or released:

```
from bluedot import BlueDot
from signal import pause

def say_hello():
    print("Hello World")

def say_goodbye():
    print("Goodbye")

bd = BlueDot()
bd.when_pressed = say_hello
bd.when_released = say_goodbye
pause()
```

BLUE DOT POSITION

The Blue Dot touch position also includes the x and y coordinates, distance and angle from the centre.

Wireless light switch

Blue Dot works really well with the gpiozero Python library (**magpi.cc/2qd2MEb**) to remotely control physical and electronic projects, and can be used to replace a gpiozero Button.

For example, you can create a wireless light switch using the **when_pressed** and **when_released** functions with an LED. Connect an LED and resistor between GPIO 17 and GND (see **Fig 1** on page 52), and create the following Python 3 program:

```
from bluedot import BlueDot
from gpiozero import LED
from signal import pause

bd = BlueDot()
led = LED(17)

bd.when_pressed = led.on
bd.when_released = led.off
pause()
```

SOURCE & VALUES

Many gpiozero objects have a source property to link components together with a values property, including Blue Dot. For example: `led.source = bd.values`

ALLOW PAIRING

You can make your Raspberry Pi discoverable and pairable for 60 seconds with `bd.allow_pairing()`. This is useful when adding a new remote.

Run the program and connect the Blue Dot app to your Raspberry Pi. Pressing the blue dot will turn on the LED, and releasing it will turn it off.

Control a robot

The Blue Dot app can detect exactly where the dot has been pressed. Using this information, the dot can act as a joystick to control a robot. Pressing the dot at the top will make your robot move forward, while pressing it on the right will rotate the robot clockwise, and so on.

Replace the **LFpin**, **LBpin**, **RFpin** and **RBpin** variables with the Left Forward, Left Backward, Right Forward and Right Backward pins which control your robot's motors:

```
from bluedot import BlueDot
from gpiozero import Robot
from signal import pause

bd = BlueDot()
robot = Robot(left=(LFpin, LBpin),
              right=(RFpin, RBpin))

def move(pos):
    if pos.top:
        robot.forward()
    elif pos.bottom:
        robot.backward()
    elif pos.left:
        robot.left()
    elif pos.right:
        robot.right()

def stop():
    robot.stop()

bd.when_pressed = move
bd.when_released = stop
pause()
```

INTERACTIONS

`db.interaction` will return all the details about what happened between the Blue Dot being pressed and being released.

At the moment, the robot's direction only changes when the dot is released and pressed again. To change it so that the direction also changes when the touch position is moved, use **when_moved**:

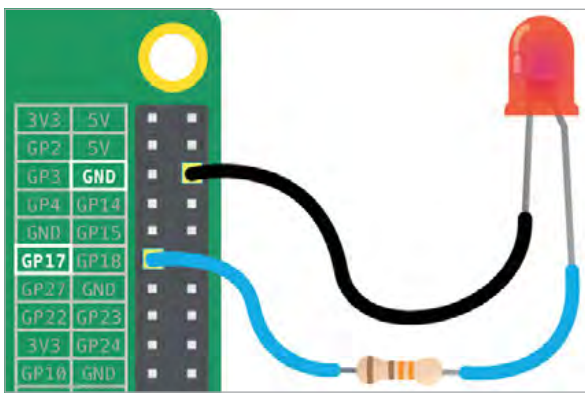


Fig 1 Set up your Bluetooth-controlled LED as shown here, connected via a resistor to GPIO 17 and GND

```
bd.when_moved = move
```

DJ scratch machine

You can swipe the dot as well as pressing it, as if you were moving between images in an app.

In this program you will create a DJ scratch machine which will play a beat in a loop, and a vinyl scratch when the blue dot is swiped:

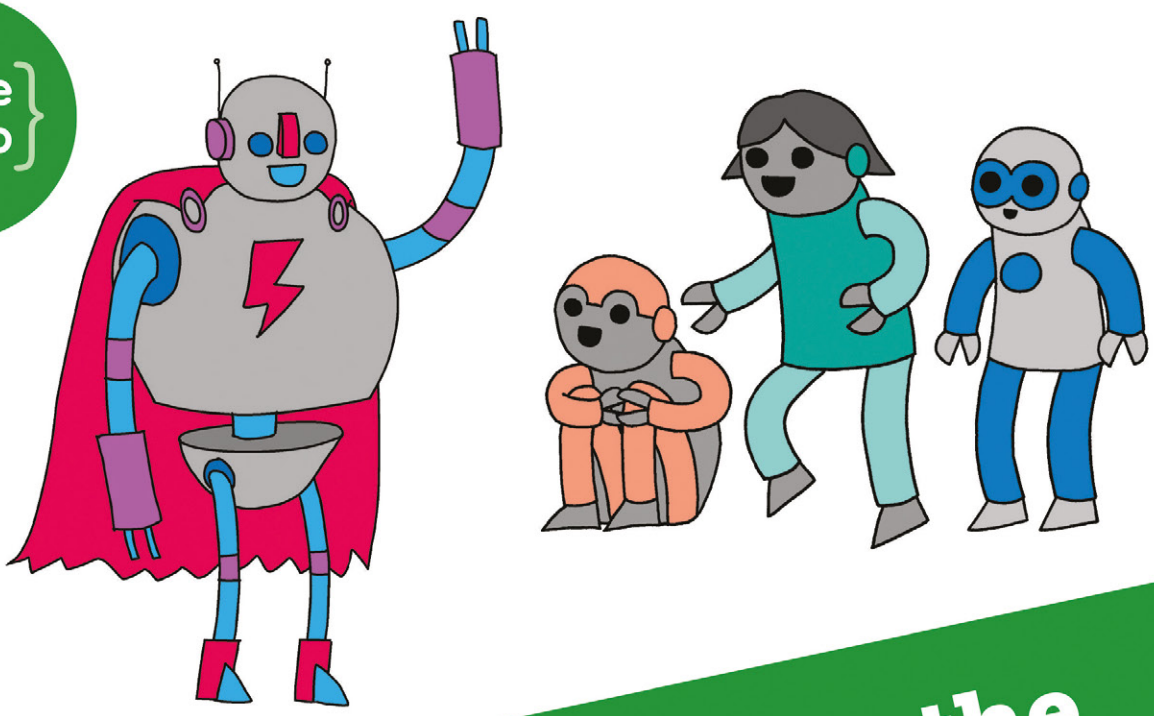
```
import pygame
from bluedot import BlueDot
from signal import pause

pygame.mixer.pre_init(buffer=512)
pygame.init()
pygame.mixer.init()

loop = pygame.mixer.Sound("/opt/sonic-pi/
etc/samples/loop_amen.flac")
scratch = pygame.mixer.Sound("/opt/sonic-
pi/etc/samples/vinyl_backspin.flac")

def scratched():
    scratch.play()

bd = BlueDot()
loop.play(loops = -1)
bd.when_swiped = scratched
pause()
```

The direction in which the dot is swiped can also be used by checking the variable that is returned by the **when_swiped** function:

```
from bluedot import BlueDot
from signal import pause

def swiped(swipe):
    if swipe.up:
        print("up")
    elif swipe.down:
        print("down")
    elif swipe.left:
         print("left")
    elif swipe.right:
        print("right")

bd = BlueDot()
bd.when_swiped = swiped
pause()
```

More ideas

You'll find a full getting started guide with lots more ideas, as well as a complete API reference, in the Blue Dot documentation (**magpi.cc/2qRf8EO**).



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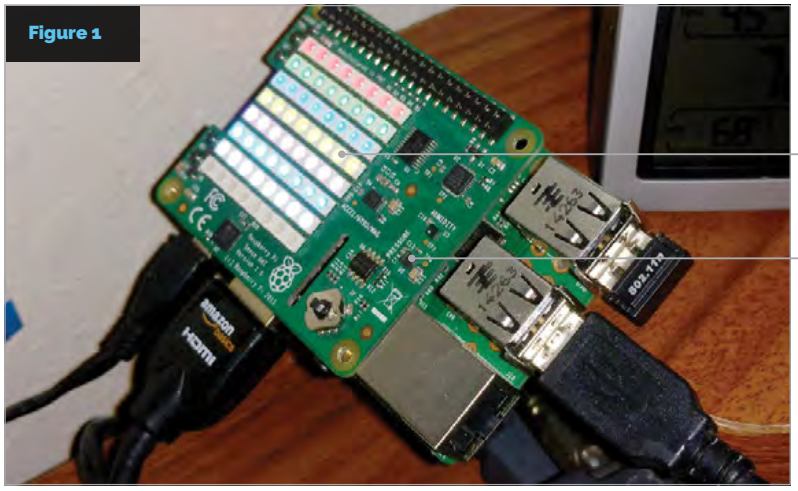
This advertising space was kindly donated to Code Club by MagPi Magazine

BRETT HAINES

Brett is a Junior Release Engineer at Wolfram Research, where he's been working with the Raspberry Pi for more than two years.
blog.wolfram.com

Figure 1



The display after passing an 8×8 array of RGB colours to the Sense HAT

Use the environmental sensors in conjunction with the LEDs

MATHEMATICA AND THE SENSE HAT

You'll Need

- Sense HAT
  magpi.cc/1TGGUt5

Collect and display environmental data using the Sense HAT and Wolfram's language function

Ever since the partnership between the Raspberry Pi Foundation and Wolfram Research began, people have been excited to discover – and are often surprised by – the power and ease of using the Wolfram Language on a Raspberry Pi.

The Wolfram Language is particularly useful in partnership with the Sense HAT, which features an LED array and a collection of environmental and movement sensors. These give users the ability to read in data from the physical world and display or manipulate it in the Wolfram Language with simple, one-line functions. With the release of Mathematica 11, Wolfram Research has been working hard to refine functions that connect to the Sense HAT, allowing Mathematica to communicate directly with the device.

Programming the Sense HAT

The Sense HAT's functionality is built on Wolfram's Device Driver Framework (**magpi.cc/2sl5Q5u**), so connecting to the device is incredibly simple. To start, use the **DeviceOpen** function to establish a connection. This will return a **DeviceObject**, which we will use later to tell Mathematica which device we want to read from or write to.

```
hat = DeviceOpen["SenseHAT"]
```

In the case of the Sense HAT, there are three on-board sensors that Mathematica can read from.

To access the data from these sensors, simply call **DeviceRead** with the name of the measurement wanted. For instance:

```
temp = DeviceRead[hat, "Temperature"]
hum = DeviceRead[hat, "Humidity"]
```

A total of seven measurements can be read from the Sense HAT: temperature, humidity, air pressure, acceleration, rotation, magnetic field, and orientation. All the readings are returned with appropriate units, making it easy to convert the values to other formats if necessary.

```
accel = DeviceRead[hat, "Acceleration"]
accelSI = UnitConvert[accel,
"Meters"/"Seconds"^2]
```

The other physical component of the Sense HAT is the 8×8 LED array. You can use the **DeviceWrite** function to send an image or a string to the array. For strings, the text scrolls sideways across the device. You can set the speed and colour of the scrolling text.

```
DeviceWrite[hat, "Hello, world!"]
DeviceWrite[hat, {"Now in color!",
"ScrollSpeed" -> 0.25, "Color" -> {255, 0, 128}}]
```

Language
>WOLFRAM

DOWNLOAD:
magpi.cc/2slmDoa

Alternatively, the Sense HAT can receive an 8×8 list of RGB values to be displayed on the LED array. Using this method, it is possible to display small images. Download and run the code from **magpi.cc/2slmDoa** to see a display like the one in **Figure 1**.

Practical uses

Using these functions, you can write Mathematica programs that process the data received from the sensors on the Sense HAT. For example, at the Wolfram Technology Conference in October 2016, the Sense HAT was demonstrated by reading the temperature, humidity and air pressure around the Pi every five minutes, and pushing that data to the Wolfram Data Drop (**magpi.cc/2slL7hF**).

```
db = CreateDatabin[]
SaveReadingToDataDrop[
   bin_Databin] := (Module[{dev, hum, temp,
pres},
    dev = DeviceOpen["SenseHAT"];
    temp = DeviceRead[dev, "Temperature"];
    pres = DeviceRead[dev, "Pressure"];
    hum = DeviceRead[dev, "Humidity"];
    DatabinAdd[
     bin, <|"temperature" -> temp,
"humidity" -> hum,
      "air pressure" -> pres|>];
    DeviceClose[dev];]);
cronTask = RunScheduledTask[SaveReading
ToDataDrop[db], 300]
```

This function generates a new databin to store data, but what does that data look like once it has been recorded? Let's look at the recordings made at the Wolfram Technology Conference (**Figure 2**).

That data was available to be downloaded into Mathematica by anyone, at any time after the conference, to show the changes in atmospheric conditions using `DateListPlot`.

```
DateListPlot[Databin["gwSkMvMW"]]["air
pressure"]
```

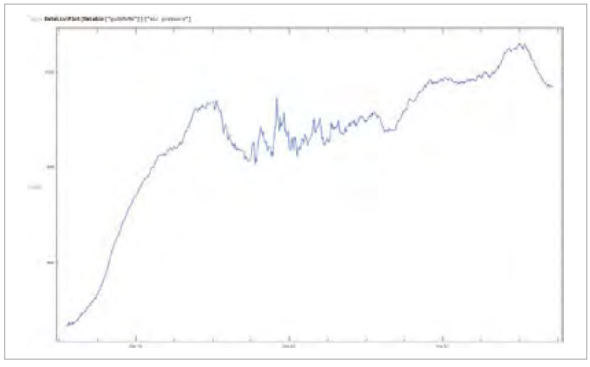


Figure 2: Air pressure readings taken by a Sense HAT at the Wolfram Technology Conference 2016

In **Figure 2**, you can see the rise in air pressure inside the conference centre as more people gathered to see the demos from Wolfram employees, followed by a drop as the conference ended.

Another demo run at the conference made use of `DeviceWrite`. Using the Wolfram Language's financial database, the Sense HAT was transformed into a miniature stock ticker. This demo downloads the current stock market data from Wolfram's servers, then picks a random stock from the list and shows the stock's name and price on the Sense HAT's LED array.

```
StockTickerPi[
   dev_DeviceObject] := (Module[{len,
price, str, stock, stockList},
    stockList = FinancialData["NYSE:*",
"Lookup"];
    Do[stock = RandomChoice[stockList];
     price = FinancialData[stock];
     If[Head[price] === Real,
      str = StringDrop[ToString[stock], 5]
<> "$" <> ToString[price];
      DeviceWrite[
       dev, {str, "ScrollSpeed" \
[RightArrow] 0.05,
        "Color" -> {200, 0, 0}}]], 100];]);
StockTickerPi[hat]
```

Let's play a game

The final demo run at the conference used the Sense HAT's LED array to run Conway's Game of Life (**magpi.cc/2slDPKT**), a famous cellular automaton. For those unfamiliar with the game, imagine each lit LED is a cell in a Petri dish. If a cell has too few or too many neighbours, it dies out. If an empty space has exactly three living neighbours, a new cell appears there. When these rules have been applied to all of the spaces on the grid, a new 'generation' begins, and the rules are reapplied. This pattern can continue indefinitely, given the right conditions. In the demo, a random array of lit and unlit LEDs constitutes the starting pattern. The automaton then runs for a given number of iterations.

Check out the code download to see how this was done. The rounds, pause, and color parameters can all be modified to change the way the automaton is displayed, and to adjust how long Mathematica waits before displaying the next iteration.

What next?

This is only a taste of what is possible with Mathematica and the Sense HAT. Visit **magpi.cc/2slJu3N** to discover more ideas for using them together. Once you've tried some of the ideas, why not share your work on the Raspberry Pi Wolfram group (**magpi.cc/2slgvNo**) to inspire other users? We'll see you there!

MIKE'S PI BAKERY

MIKE COOK

Veteran magazine author from the old days and writer of the Body Build series. Co-author of *Raspberry Pi for Dummies*, *Raspberry Pi Projects*, and *Raspberry Pi Projects for Dummies*.
magpi.cc/259aT3X

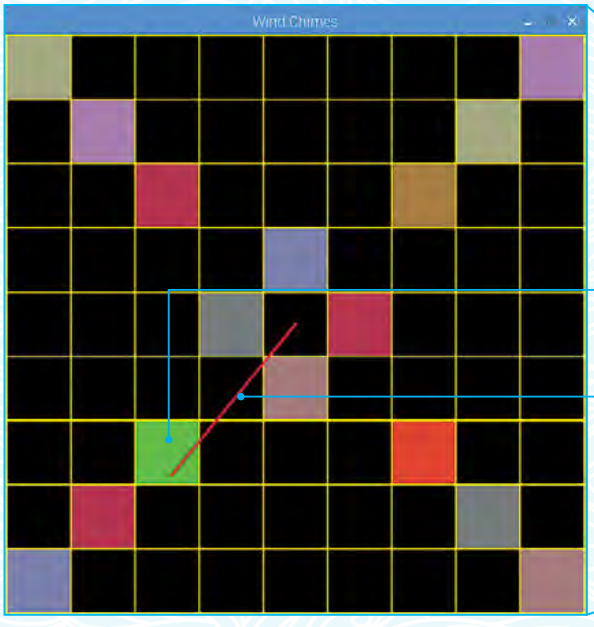
ELECTRONIC WIND CHIMES

You'll Need

- Magnetometer HMC5883L board
- 2× M2.5 brass or nylon nuts and bolts
- Magnet
- Pendulum assembly: aluminium extrusions

Detect a magnetic vector to ring your chimes with Raspberry Pi

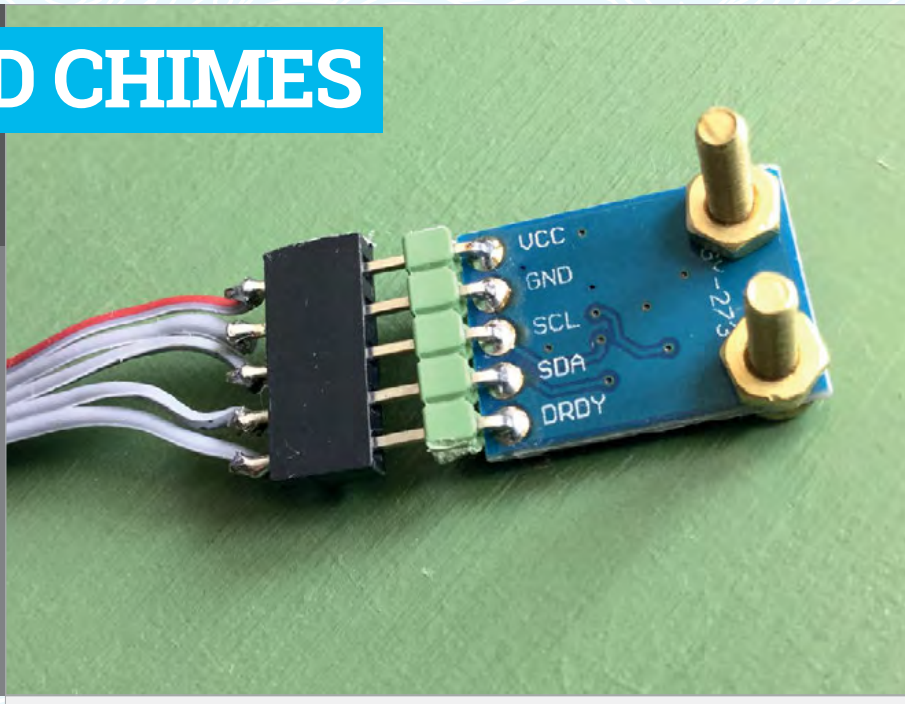
A recent visit to a local garden centre saw us musing on the collection of wind chimes. The designs ranged from the naff to the awesome, depending on how the sounds were generated, and that sparked the inspiration for this month's project. We had tackled electronic wind chimes many years back but we used individual reed switches under a swinging magnet. This version uses a magnetometer to detect the pendulum's movement, and software to decide when a note is triggered. Of course, being controlled by software, the sounds it could produce are almost unlimited.



CREATING **WIND CHIMES**

>STEP-01
The sensor board

Solder the pin headers onto the magnetometer board. Ours came with a vertical header, so we swapped this for a right-angled one; this allowed the pendulum to swing much closer to the sensor. Make up a five-way ribbon cable lead with a socket on both ends to connect the sensor and the Pi. Mark one end of each connector with a spot of correcting fluid to make sure it is the right way round. Fix two 10 mm long M2.5 brass screws to the ready-drilled holes and loosely tighten the nuts. They need to be brass, aluminium or nylon screws so that they do not affect the magnetic field – we used brass.



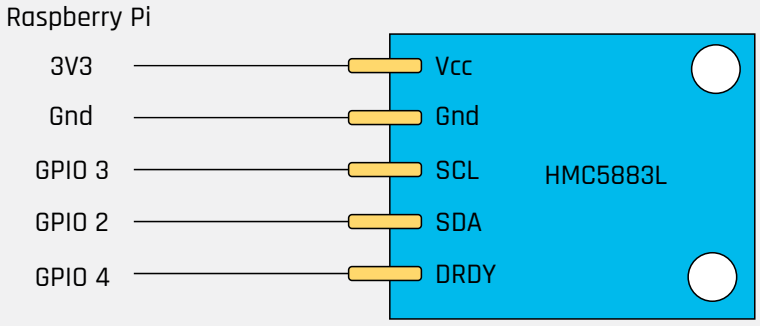


Figure 1 Wiring the magnetometer board to the Raspberry Pi

A magnetometer is a popular sensor these days. Often called a compass module, it is to be found on the Sense HAT, micro:bit, and various low-cost modules from many suppliers. They are used in many smartphones and tablets, but we always considered their use on a fixed computer system to be a bit limited, as you're not likely to move your desk. The sensor is based on the magneto resistance effect first discovered by Lord Kelvin in 1856. He discovered that the resistance of metals could change in a magnetic field. Magnetic fields are measured in tesla, but often expressed in the more convenient unit of gauss, 10,000 gauss being equal to 1 tesla. The magnetic field at the surface of the Earth is in the range 0.25 to 0.6 gauss. Fundamentally, magnetic fields are defined by the force they exert on a moving charged particle. Magnetic force acts as a field, and the field's strength is different in each of the three dimensions. Measurement of the force is in the form of a vector: a value that describes the strength and direction of the magnetic field.

The HMC5883L module is manufactured by Honeywell and can be used as a compass with a 1° to 2° heading accuracy. It can output a 12-bit reading from fields of 8 to 0.8 gauss, depending on the software settings. We are going to suspend a magnet from a pendulum on a universal pivot, created by hanging the pendulum from a thread. In this application it is important to understand that we are measuring the two-dimensional magnetic field vector, which is related to the position of the pendulum, but also depends on the orientation of the magnet and the sensor. Then all we have to do is trigger the playing of a sound sample when certain field vectors are measured.

Wind chimes in action

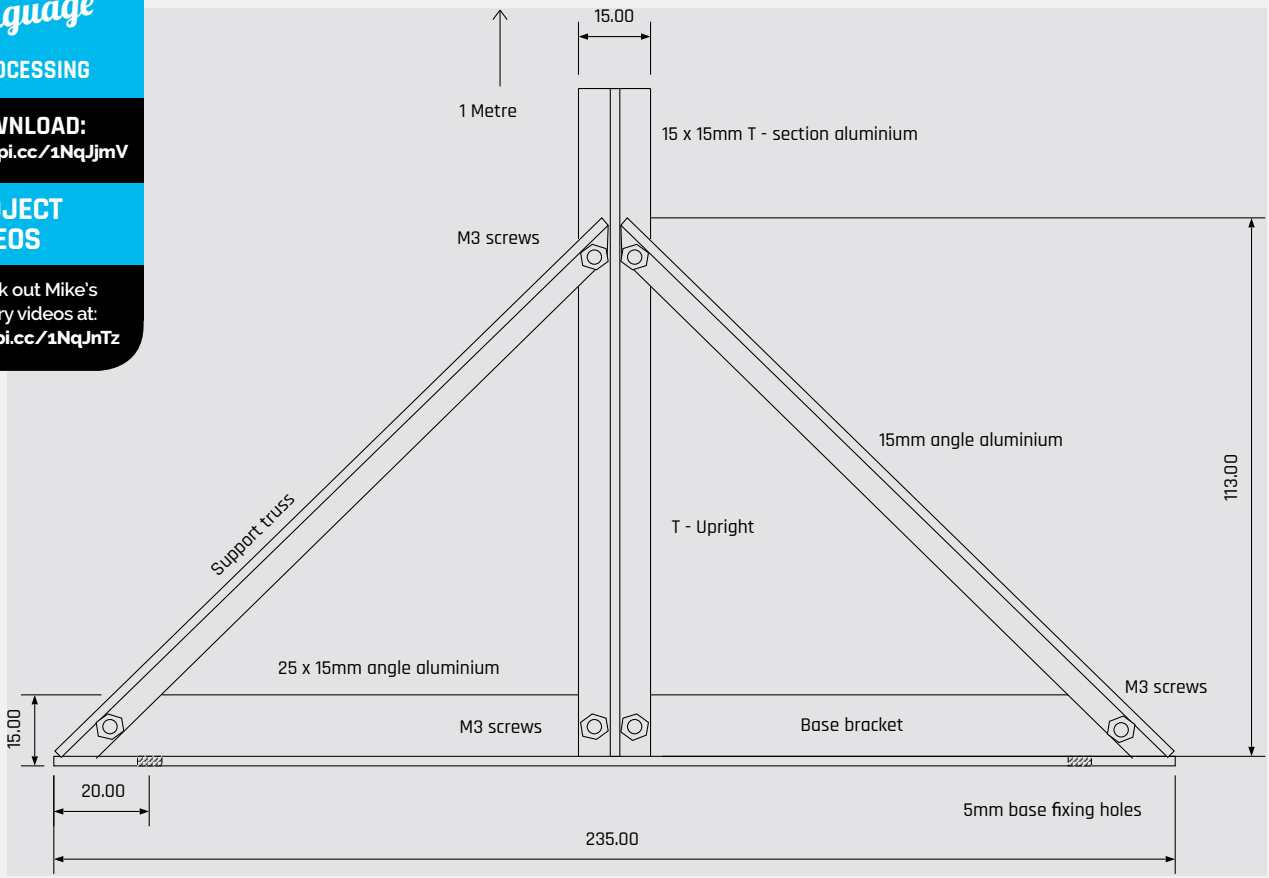
The magnetic vector is plotted onto a 9 × 9 square grid, and each of these grid points may or may not trigger a sound sample. Whether it does or not, and what sample it triggers, is selected by the user clicking on a grid square. The squares start off black, indicating no sound. Clicking on them will toggle an associated sound on or off. The sound you seed in this way is set up by the number keys 1 to 9, each corresponding to a different sound sample. The magnetic field vector is plotted over the top of this grid. When it ends in a coloured grid square, that square's sound is triggered.

> "Magnetic fields are defined by the force they exert on a moving charged particle"

Language
>PROCESSING

DOWNLOAD:
magpi.cc/1NqJjmV

PROJECT VIDEOS
Check out Mike's Bakery videos at:
magpi.cc/1NqJnTz



>STEP-02
Build the base

The frame is built from various lengths and profiles of extruded 2 mm aluminium. The base starts with a 235 mm section of 25 × 15 angle aluminium. We used M5 nuts and bolts to attach it to a 250 × 420 mm, 12 mm thick, painted MDF base. Counter-drill the other side of the board so the screw heads are flush with the bottom of the board. The vertical upright is made from a one-metre length of T-section aluminium, and is attached to the base bracket with two M3 screws. The vertical upright is stabilised by two 160 mm trusses made from 15 × 15 mm angle aluminium. Note that the ends of these are cut off at an angle so that they sit flush with the other brackets. The base bracket also has its corners cut off to be flush with the trusses.

Just a word of caution: if you are buying a HMC5883L module, there are some fake modules about on eBay that claim they are HMC5883L devices but are in fact a QMC5883. While the latter is a magnetic sensor, it has a very different internal structure, different capabilities, and will not work with the software here. On a real HMC5883L, that the chip is marked L883, whereas the 'fake' chip is marked DA5883. If you do get a fake, you should ask for a refund on the grounds that it's not what was advertised.

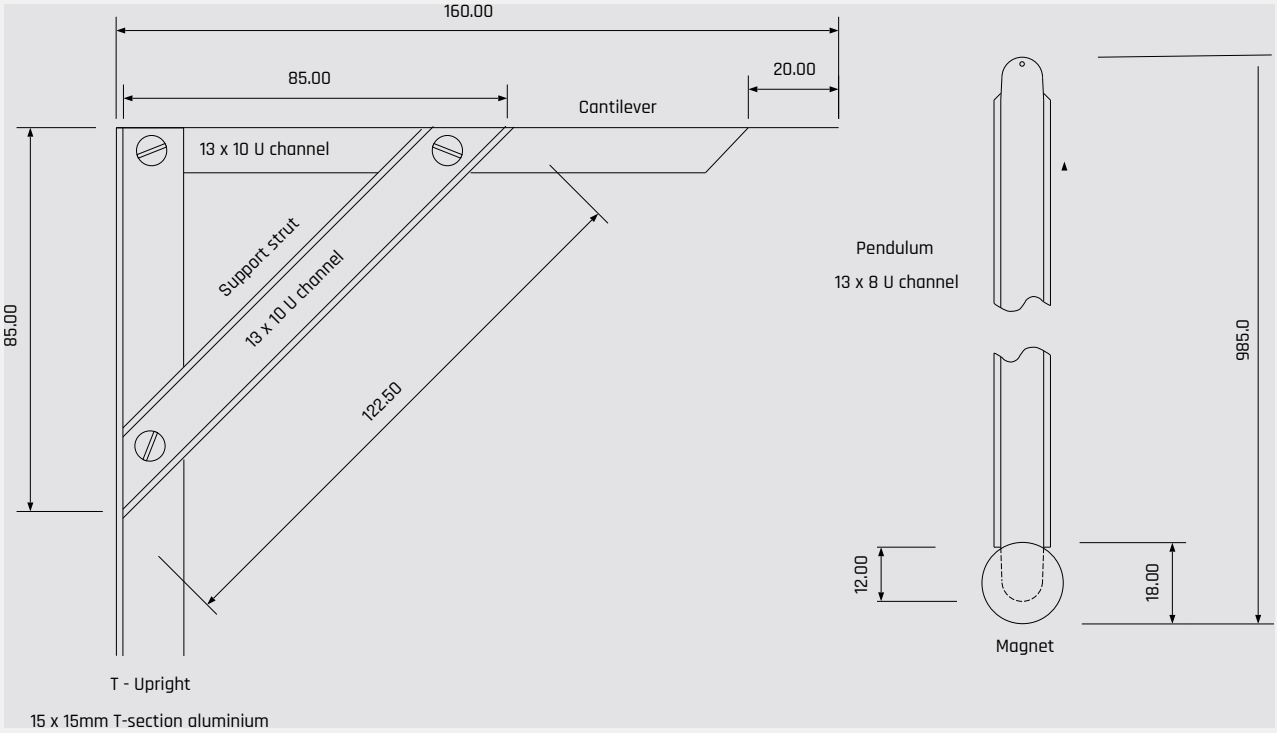
The HMC5883L chip has an I²C interface and runs from 3V3, so is easy to interface to the Pi. **Figure 1** (page 57) shows the wiring you need. We also added a wire for the data ready signal, but we found that it was not needed for this project. Full construction details are shown in the step-by-step guide.

Software

These days it is not necessary to run as the 'root' user to access the hardware – just make sure the I²C interface is enabled in the Interfaces tab of Preferences > Raspberry Pi Configuration.

The software, **chimes.py**, is written in Python 3 and runs under the Pygame framework. The **`sampleC`** list determines the colour of each seed note and is easily changed if you don't like our selection. The whole display size is controlled by the variables **`gSpace`** and **`gSide`**, making it easy to customise. An odd number of squares ensures that you have a central square position. The main loop is simple enough, but you might be puzzled by the small delay when a note is triggered. We thought it worked better like that, but you could remove it if you prefer an instant sound.

The magnetic vector has a large amplitude when the magnet is over the sensor, but a smaller magnitude when it is further away. To make the vector measurement easier to understand, we inverted the value to match the movement of the pendulum. To do this, we took the reciprocal of the vector's amplitude when we applied the scale factors.



>STEP-03
Build the top

The top of the frame consists of a cantilever to hold the pendulum, and a supporting strut, both made from 13 × 10 mm U channel aluminium. The cantilever is mounted on one side of the T upright, and the strut on the other. From about 20 mm from the end of the cantilever, remove the sides of the U channel with a saw and file, and drill a 1 mm hole about 3 mm from the end. Cut off the ends of the support strut at an angle of 45° and attach it with two M3 screws.

The pendulum is made from a 980 mm length of 13 × 8 mm U channel aluminium. At each end, take out the final 12 mm of the channel sides with a file and round the ends. Then drill a 1 mm hole in the top, and use silicon sealant to glue a 12 mm diameter magnet to the bottom.

>STEP-04
Finishing off

Attach the pendulum to the cantilever with a strong but flexible thread, allowing the magnet to swing just clear of the magnetometer and fixing screws. Make sure there are no sharp edges that could cut through the thread as it swings. Screw the whole structure to the base, sit it on a flat surface, and let the pendulum come to a rest. Position the sensor board so that the chip is directly under the pendulum, and mark the positions of the two holes in the sensor board. Drill these out with a 2.5 mm drill. To mount the sensor board, slacken off the screws, push them into the holes, and then tighten up the screws. This will provide you with a solid blind fixing.

Taking it further

You can play about with the scale factors and change the sounds by adding other samples. However, one big enhancement you could make is to turn on a fan when you detect that there has been no note triggered for ten seconds or so. This would be great for indoor use.

However, you could add a bit more variety in the swing by taping some reed switches to the base. This will remove subtle amounts of kinetic energy from the pendulum as it passes, and produce a more chaotic swing. We did not do anything with the Z axis of the vector, so maybe you can come up with a use for that.

ATTACH A SERVO TO AIY PROJECTS

You'll Need

- 9 g micro servo
- 4×AA battery pack
- AIY Projects Voice HAT

GET YOUR AIY PROJECTS KIT

If you didn't manage to get hold of an AIY Projects kit, don't worry – Google hopes to have more available soon. Sign up for our newsletter, and we'll let you know when more AIY Projects Voice Kits are available: **magpi.cc/Email-me**

Servo motors are used to perform fine motor functions, and with AIY Projects you can program them for voice activation

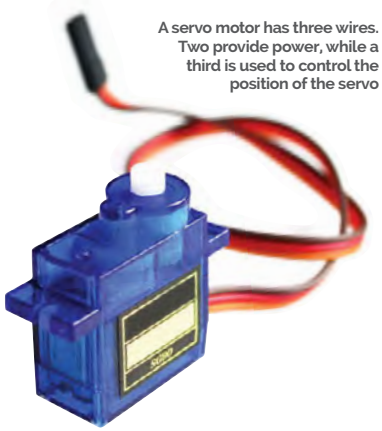
One of the big hopes for AIY Projects is that Raspberry Pi owners will integrate the kit into their own projects. In our last tutorial for AIY Projects, we looked at hooking up the hardware to control an LED light (a typical first hardware project). Here, we're going to take things up a notch and hook up a servo to the AIY Projects board.

On the Voice HAT hardware you will see two columns of pins. The one on the left (marked Servos) is for servos, and has a 25 mA drive limit. The one on the right, marked Drivers, is typically used for motors and has a 500 mA limit. You can connect wires directly to the Voice HAT hardware, but it's easier to prototype your circuits by soldering the pins (supplied with the kit) to the board.

>STEP-01

Servo motors

Servo motors move in a circular motion to a set position. They are often used to control robotic arms and legs, grippers, and the position of surfaces (like elevators and rudders on an RC plane).



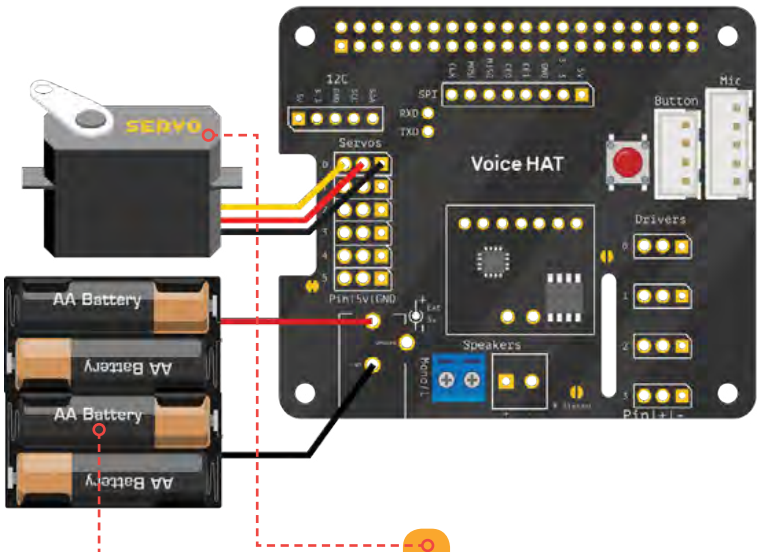
A servo motor has three wires. Two provide power, while a third is used to control the position of the servo

It is relatively easy to hook up a servo motor to a Raspberry Pi, but the AIY Projects Voice HAT board makes it even easier, with a dedicated column of pins designed to control servo motors. Connecting your servos using the Voice HAT allows them to be controlled using voice commands and the Cloud Speech API

>STEP-02

Servo control

Servo motors are controlled using pulses generated by a GPIO pin on the Raspberry Pi (we're using GPIO 26 on the AIY Projects Voice HAT board). The servo motor expects a pulse (the GPIO pin to be turned on, or high, and then off again) every 20 milliseconds. The length of the pulse determines the position of the servo arm. If it's 1 ms then the servo arm is rotated towards the left; 1.5 ms puts it at the mid-point; 2 ms and it's all the way to the right. The starting position from which servos rotate varies (and some move all the way around).

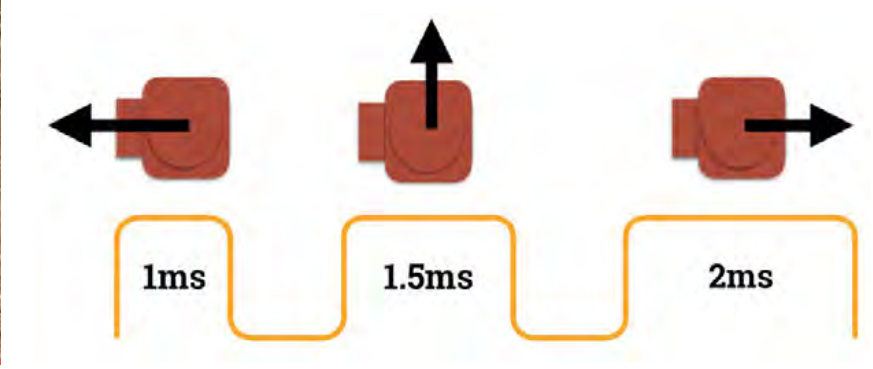


AA BATTERY

Provide a more stable power supply to the servo by connecting a 4×AA battery holder to the two power inputs on the board

SERVO

The three wires from the servo are connected to row 0 on the Servos rail. Make sure you connect the Pin, 5v, and GND wires in the correct order



Above: A servo motor measures the length between pulses (a GPIO pin being turned rapidly on and off). When the pin is on for 1 ms, the servo moves to the low position. When it's on for 2 ms, it moves to the high position. Other pulse lengths are used to set it between low and high

The code for detecting these pulses and moving the servo around is provided with the GPIO Zero library, which works with AIY Projects.

>STEP-03
Connect the servo

We're using a standard 9 g micro servo in this tutorial. These are tiny 5 V servos with an operating voltage of 4.8 V. Each servo comes with three wires: usually these are red, brown, and orange. Red and brown provide power to the servo, and are live and neutral respectively, while the third wire detects the pulse. Make sure your Raspberry Pi is powered down, and connect the servo wires directly to the Servos 0 row on your AIY Projects Voice HAT. Many servos have all three wires bundled into a JR connector; this can be plugged directly into the Voice HAT board. Be sure to fit it the correct way around, with the orange/yellow cable in the GPIO pin on the left.

>STEP-04
Add Power

The 5 V running through the GPIO pins on the Raspberry Pi is enough to power a very small servo. However, with this model, you are likely to crash the Raspberry Pi, as it draws too much current to power the motor and the Raspberry Pi itself. You should provide power for the servo from an external battery. Servos require 4.8–6 V DC power to the motor, which can be provided from a 4×AA battery pack. Connect the red wire to the positive terminal on the Voice HAT board, and the black wire to the negative.

>STEP-05
Test it out

Before coding the servo to respond to your voice commands, you can test the circuit using GPIO Zero in Python. Open IDLE 3 and enter the code from **servo.py**. Save the code and press **F5** to run it. The servo will move from its minimum position to the mid-point, and then to the maximum position with a pause between each step. Press **CTRL+C** to quit the program and stop the movement. If the servo doesn't work, double-check your connections.

>STEP-06
Integrate with voice

Now that the servo is working, it's time to integrate it with the AIY Projects code by modifying the **action.py** script. Open the latter in TextEdit:

```
xdg-open /home/pi/voice-recognizer-raspi/src/action.py
```

Now add the code from **add_to_action.py** to the 'actions' and 'voice command' sections (highlighted as comments in the code). Run **src/main.py** and press the button on your AIY Projects Voice HAT board. Now say "change to minimum" or "change to maximum" to move the arm up and down. Saying "change" and any other command moves the arm back to the middle.

add_to_action.py

```
# ========================================
# Makers! Implement your own actions here.
# ========================================

from gpiozero import Servo
from time import sleep

class ServoMove(object):
    def __init__(self):
        self.servo = Servo(26)
        #self.value = value

    def run(self, voice_command):
        if 'maximum' in voice_command:
            self.servo.max()
        elif 'minimum' in voice_command:
            self.servo.min()
        else:
            self.servo.mid()

    # ========================================
    # Makers! Add your own voice commands here.
    # ========================================
    actor.add_keyword('change', ServoMove())

    return actor
```

servo.py

```
from gpiozero import Servo
from time import sleep

servo = Servo(26)
while True:
    servo.min()
    sleep(1)
    servo.mid()
    sleep(1)
    servo.max()
    sleep(1)
```

Now everything is working, you can attach the servo to the side of the kit's cardboard box. On the side of the kit, you'll see an arc-shaped hole. Most small servos will fit in this space. Twist the servo to lock it in place. Try adding a wooden or 3D-printed arm to the servo so you can clearly see it moving.

GPIO ZERO

Our code uses the GPIO Zero Python library to control the servo. You can learn more about controlling projects with GPIO Zero in our Essentials book, *Simple Electronics with GPIO Zero*: **magpi.cc/2bA3ZP7**

CONTROL A DC MOTOR WITH YOUR VOICE HAT

You'll Need

- DC motor
- 4×AA battery pack
- Breadboard and jumper wires
- Utility / Stanley knife

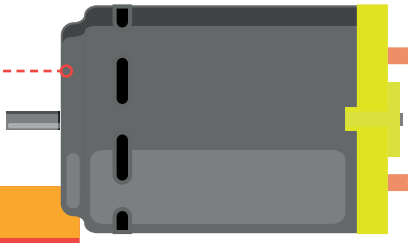
Connect a motor to your AIY Projects Voice HAT board

In our recent AIY Projects tutorials, we've looked at how to move beyond using the Voice Assistant, and towards using your Voice HAT with basic electronics.

If you've been following our tutorials, you will have discovered how to connect the Voice HAT hardware to simple circuits. So far we've looked at how to control LED lights and servo motors, but in this tutorial we'll look at something a little more complex: using the AIY Projects Voice HAT to control a motor.

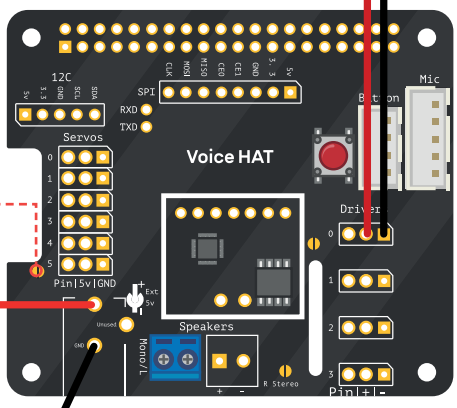
>STEP-01
Cut the power

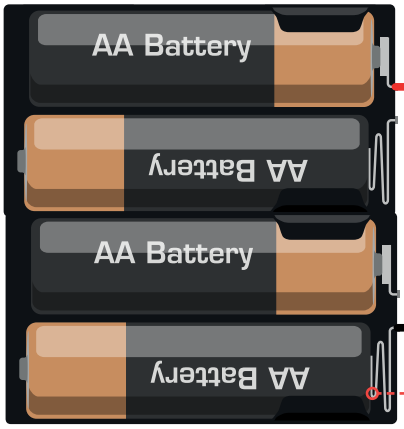
The first thing you need to do is isolate the Raspberry Pi's power supply from the power on the Voice HAT board. This will prevent the DC motor from draining too much power and shorting out your



DC MOTOR

The DC motor connects to the positive and negative voltages via two wires. The direction in which the motor moves depends on which way around the two wires are placed.





EXTERNAL POWER SOLDER JUMPER

You need to cut the external power solder jumper, located just to the left of Servos 5 on the board. This isolates the Voice HAT power from the Raspberry Pi.

AA BATTERY PACK

The DC motor draws more power than the Raspberry Pi can safely provide, so a 4×AA battery pack provides power for the DC motor.

add_to_action.py

Language >PYTHON

```
# ========================================
# Makers! Implement your own actions here.
# ========================================

from gpiozero import PWMOutputDevice

class MotorMove(object):
  def __init__(self):
    self.pwm = PWMOutputDevice(4)

  def run(self, voice_command):
    if 'on' in voice_command:
      self.pwm.on()
    elif 'off' in voice_command:
      self.pwm.off()

  # ========================================
  # Makers! Add your own voice commands here.
  # ========================================
  actor.add_keyword('motor', MotorMove())

  return actor
```

motor.py

```
from gpiozero import PWMOutputDevice
from time import sleep

pwm = PWMOutputDevice(4)
while True:
  pwm.on()
  sleep(1)
  pwm.off()
  sleep(1)
  pwm.value = 0.5
  sleep(1)
  pwm.value = 0.0
  sleep(1)
```

Raspberry Pi. Locate the external power solder jumper marked JP1 (just to the left of Servos 5 on the Voice HAT board). Use a utility knife to cut the connection in the jumper (you can always re-solder this joint if you wish to share the power between the board and the motor again).

>STEP-02
Power off

Make sure your Raspberry Pi and Voice HAT board are powered off. Now connect the positive leg of the DC motor to the middle pin on Drivers 0. Notice that at the bottom of the Driver pins is a '+' symbol.

>STEP-03
Wire for power

Next, connect the negative wire of the motor to the '-' pin on Drivers 0 (the pin on the right). You may have noticed that we're not connected to the GPIO Pin on the left (which is GPIO4); this doesn't matter as it also controls the negative '-' pin that we have just connected to. This allows us to turn the motor on and off.

>STEP-04
Power up

Finally, connect the 4×AA battery pack to the +Volts and GND pins at the lower left-hand corner of the Voice HAT. This pack will ensure that the motor has enough power when you are using the Voice HAT, which will prevent your Raspberry Pi from crashing. Connect the power and turn on the battery pack.

>STEP-05
Turn on the Pi

Now turn on the Raspberry Pi and boot into the AIY Projects software. Enter the code from **motor.py** to test the circuit. We are using **`PWMOutputDevice`** from GPIO Zero to control the motor. This enables us to manage the speed of the motor (**magpi.cc/2tnAGrz**). We can use the **`.on()`** and **`.off()`** methods to start and stop our motor. Alternatively, we can set the value instance variable to a value between 0.0 and 1.0 to control the speed. Both techniques are shown in the **motor.py** code. You can also use **`pwm.pulse()`** to pulse the motor on and off.

>STEP-06
Hook it up to the Voice Assistant

Now that we've seen how to control the motor using GPIO Zero, it is time to integrate it with the Voice Assistant. Enter the code from **add_to_action.py** to the relevant sections of **/home/pi/voice-recognizer-raspi/src/action.py** and run **`src/main.py`**. Push the button on your Voice HAT board and say "motor on" to start the motor running; push the button again and say "motor off" to stop it.

FREQUENTLY ASKED QUESTIONS

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THE BASICS

I'M NEW TO RASPBERRY PI AND...?

Does it run on Windows/Mac?

The Raspberry Pi is a full computer so you don't need to run it on another computer – it runs itself. You can use any other computer system to set it up, though, by installing operating systems to the SD card, or by transferring files from one to the other with a USB stick.

Which Raspberry Pi do you recommend?

The Raspberry Pi 3 is the flagship model, and the most powerful version. It also comes with built-in wireless LAN and Bluetooth, as does the Raspberry Pi Zero W. The latter is very small, but not as powerful as the Raspberry Pi 3. A lot of Raspberry Pi projects will work on both models. The other models are cheaper than the Pi 3, but are not as powerful and don't have wireless LAN or Bluetooth built in.

Do I need a case?

Not necessarily. The Raspberry Pi is pretty tough, but don't use it on a metal table while it's naked. Cases are generally very cheap and come in an assortment of styles for all types of Raspberry Pi, so there's no reason not to get one.

TROUBLESHOOTING FOR BEGINNERS

The light comes on but the screen is black

The most common cause of a black screen is that the SD card is blank, hasn't been written to properly, or is just not pushed in all the way. Disconnect the power, make sure the SD card is pushed in, and try again. If that doesn't work, download the operating system again and reinstall it.

There's a rainbow square in the corner

If you're seeing the rainbow square, it's the Raspberry Pi letting you know that it isn't receiving enough power. If the Raspberry Pi is performing well, you can probably ignore it, but if add-ons aren't working or programs are running very slowly, you'll need to upgrade to a 2.5 A micro USB power supply.

What's the user name and password?

The default user name on Raspbian is 'pi', and the password is 'raspberry'. This is the same on every Raspberry Pi running Raspbian, so you should change the password in the Raspberry Pi Configuration settings. These can be found in the menu in the top left-hand corner of the screen.

HARDWARE QUESTIONS

What do I need to run a Raspberry Pi?

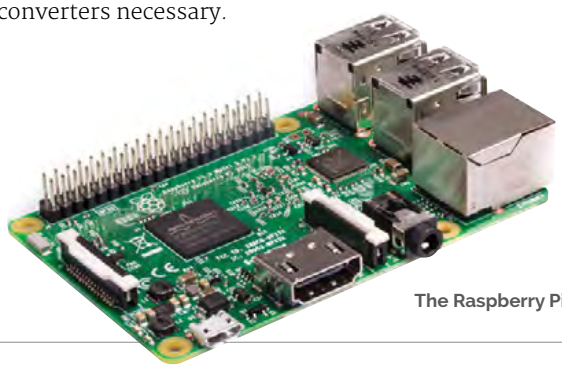
At the very least, you need an SD card, mouse, keyboard, monitor, and power supply. For older Raspberry Pi models you'll need a WiFi dongle or a wired internet connection. With some tweaking, if you need to, you can run your Raspberry Pi without a monitor, mouse, or keyboard.

What size SD card should I use?

Physically, you need a microSD card for almost all versions of the Raspberry Pi. The original Model B and Model A require a full-sized SD card. We recommend an 8GB card so that you have plenty of room to install your choice of operating system.

What else do I need for a Raspberry Pi Zero?

You'll need a micro USB (male) to USB A (female) adapter. A small USB hub will allow you to connect a few devices. You may also need an adapter for the mini HDMI port. Alternatively, look for cables that connect from mini HDMI straight to HDMI with no dongles or converters necessary.



The Raspberry Pi 3

FROM THE RASPBERRY PI FAQ
RASPBERRYPI.ORG/HELP

Does the device have support for any form of netbooting or PXE?

Yes. The Raspberry Pi 3 can be set up to network-boot without an SD card present. Earlier models can PXE/netboot with an appropriately set up SD card.

There is also PiNet, which is a free and open-source community-based project initially designed for schools. Each Raspberry Pi boots from a small set of startup files on an SD card, and fetches the rest of the data it needs from the PiNet server, thereby allowing you to maintain a single operating system image for all the Raspberry Pis on the network. PiNet also adds network user accounts, shared folders, and automated backups.

What educational material is available?

For children, we particularly recommend *Adventures in Raspberry Pi*, a book by Carrie Anne Philbin, who works with us at the Raspberry Pi Foundation. On our resources pages we offer free educational materials; you'll find complete schemes of work linked to the curriculum for England, Wales, and Northern Ireland, as well as resources for independent and informal learning. We also offer free online training materials for educators and other interested users. Find our resources at **raspberrypi.org**.

GLOSSARY

BGA: Ball grid array. A type of surface-mount packaging for electronics.

Brick: To accidentally render a device inert by making changes to software or firmware.

Distro: A specific package ('flavour') of Linux and associated software.

GPIO: General-purpose input/output. A pin that can be programmed to perform a wide range of tasks.

GPU: Graphics processing unit. The hardware that handles the graphics.

PoE: Power over Ethernet. Enables a device to be powered via an Ethernet cable.

PXE: Preboot execution environment. A way to set up a device to boot via the network.

SoC: System on a chip. A computer on a single chip.

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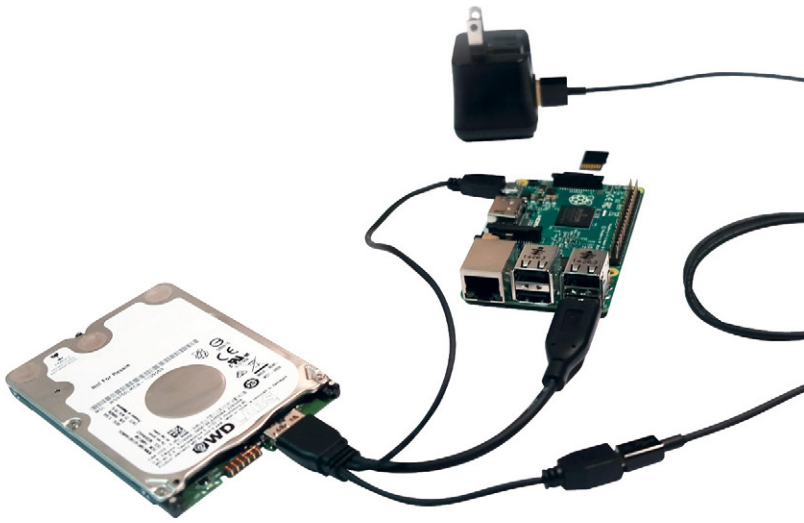

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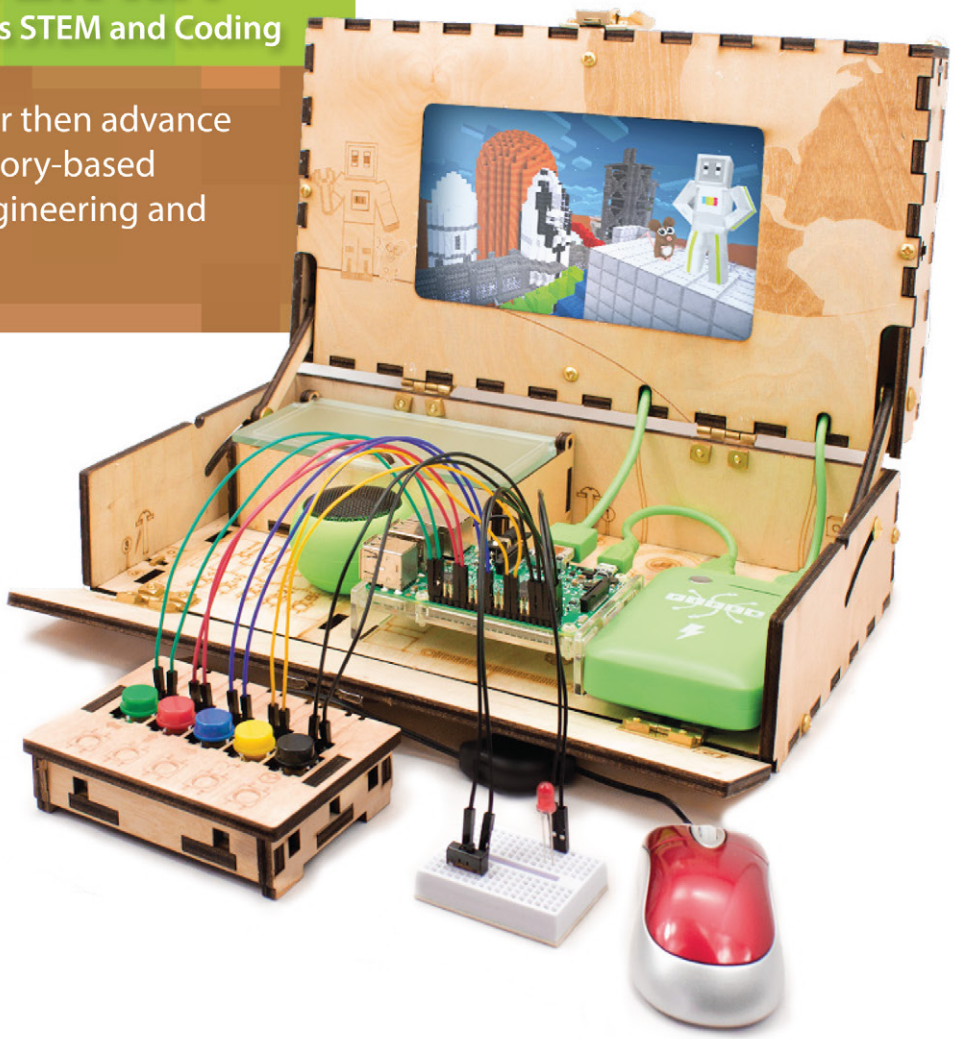

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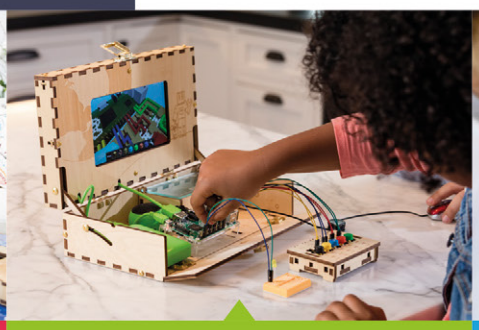

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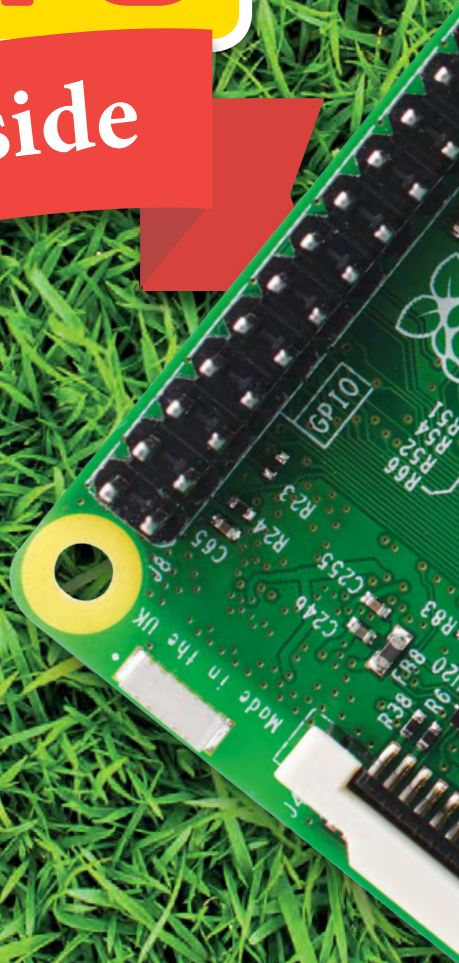
SUMMER PROJECTS

Let's take this outside

Summer's here, so why don't you unplug your Pi and go outside? Use a battery pack to take your Pi with you, of course! In this issue, we celebrate the great outdoors with twelve ideas you can use to make the most of the (hopefully) good weather. You'll see how to build a weather station, how to launch a high-altitude balloon with a Raspberry Pi tracker, and how to photograph the wildlife in your garden with hidden Pi-powered cameras. If you're a sporty type, we've got some upgrades for your bike or skateboard too. Let's go!



Raspberry Pi 3 Model B V1.2
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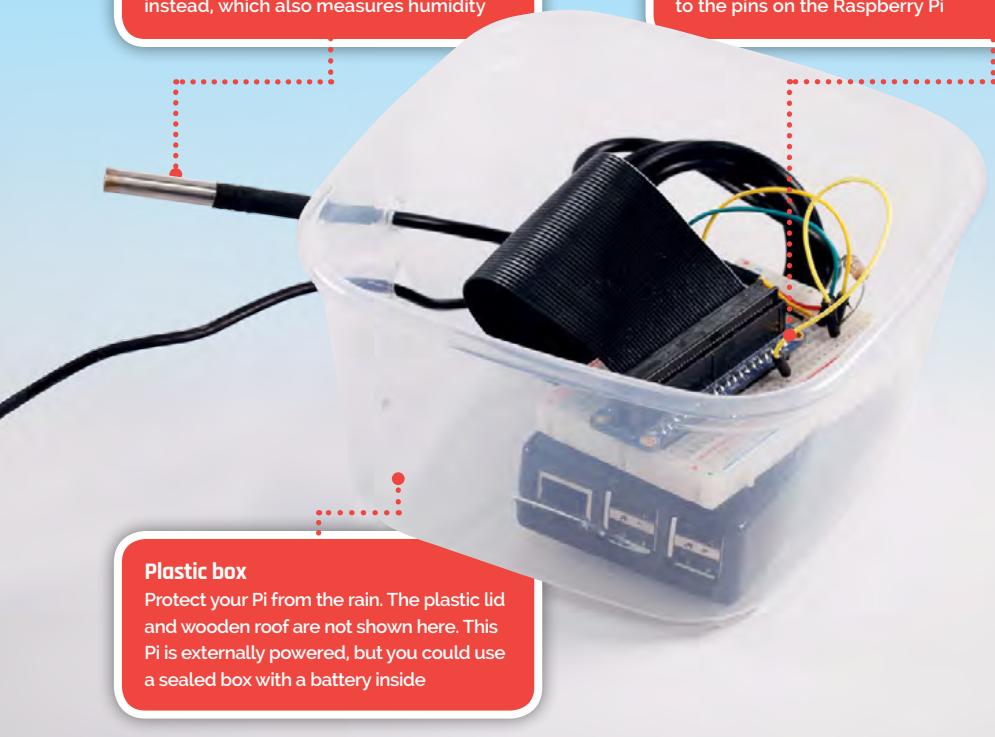
BUILD A WEATHER STATION

Is it me, or is it hot today?



Temperature sensor
The DS18B20 is a waterproof temperature sensor that gives consistent and fast results. You could use the DHT22 sensor instead, which also measures humidity

Pi Cobbler breakout cable
The Pi Cobbler breakout cable connects all the GPIO pins to the breadboard, making it easy to connect the sensor to the pins on the Raspberry Pi

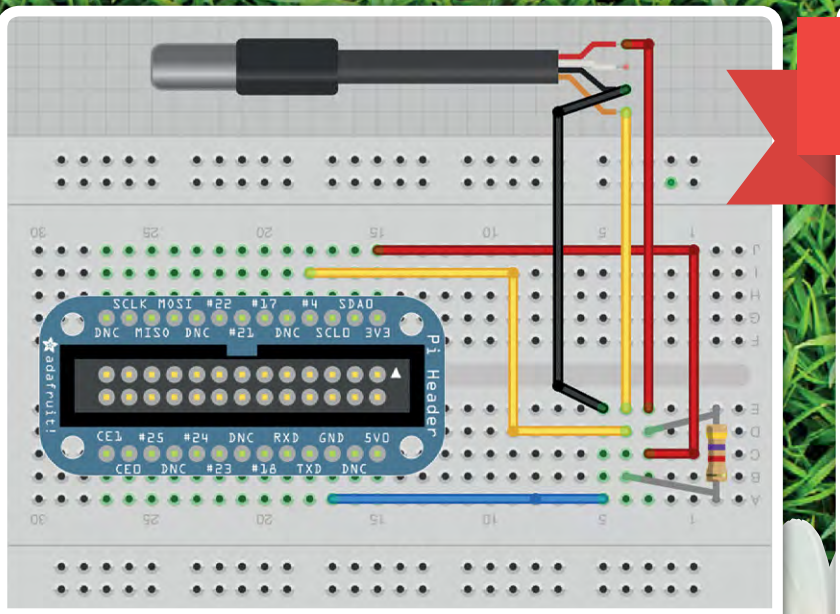
Plastic box
Protect your Pi from the rain. The plastic lid and wooden roof are not shown here. This Pi is externally powered, but you could use a sealed box with a battery inside

Come rain or shine, a weather station makes a great project for your Raspberry Pi. With a budget of around $100, Peter Kodermac built a Pi-powered weather station that captures temperature data, graphs it, and publishes it online. His website provides step-by-step instructions to walk you through the process, which involves some simple wiring, and setting up the Raspberry Pi as a web server.

For the sensor, Peter recommends the DS18B20. It's waterproof and comes with a long cable so you can keep the sensor away from the weather station, which might generate heat. The DS18B20 doesn't measure humidity, so if you want to track humidity, try the DHT22 instead. Peter warns that the DHT22 tends to give less consistent values and can take more than one attempt to get a reading.

YOU'LL NEED

- Raspberry Pi
- Breadboard
- DS18B20 or DHT22 sensor
- Plastic box
- 4.7 kΩ resistor
- Adafruit Pi Cobbler breakout kit (26- or 40-pin)



Connecting the sensor to the Pi. Image: Simon Monk (CC-BY 3.0), made with Fritzing v0.7.5. Image is creative commons cc-by (magpi.cc/2sxjBhu) from magpi.cc/2sYABdM

Peter's code, available through GitHub, is designed to compensate for that, automatically retrying where necessary.

Peter uses a Pi Cobbler breakout cable and a breadboard to make it easy to connect the sensor to the Raspberry Pi. Make sure you buy the correct Cobbler cable for the model of Raspberry Pi you are using! Everything is housed in a plastic food box, with a hole for the power cable to go in, and for the sensor cable to come out. A wooden roof offers shelter, and Peter puts silica gel sachets inside the box to offer additional protection from moisture.

There were several stages involved in setting up the software for Peter's project. First, he installed MySQL and used it to create a database for WordPress, which he uses to store the weather data. Then he installed and configured Apache and WordPress. He installed the Raspberry Weather plugin for WordPress, to generate a graph of the latest temperatures when anybody viewed the webpage. Finally, he used a Python script to query the sensor and put its data into the database, and Cron to schedule the script to run every 30 minutes. "The whole process of setting up a web server can be a bit frustrating at times, but it is totally worth the time and effort," Peter says. "It's just so great to build your site from scratch and see other people visit it and give you feedback!"

Peter has run the project on almost all versions of the Raspberry Pi. "WordPress is a bit of a memory hog, so the website loads more slowly on the Pi Zero, or older versions of the Pi. That's why I also included a neat caching trick to speed up things a bit."

You can also monitor the results on your Android phone, using an application called My Weather Station. It displays the latest data from an XML file, which is updated in parallel with the main WordPress database.

Since Peter shared his weather station design, other makers have added cameras, wind-speed and air-pressure sensors, and are calculating forecasts. If you build one, let Peter know. "I have always felt great pride in publishing links to the people who have completed the guide," he says. "I get a nice fuzzy feeling when other people improve my code, too – all thanks to open source."

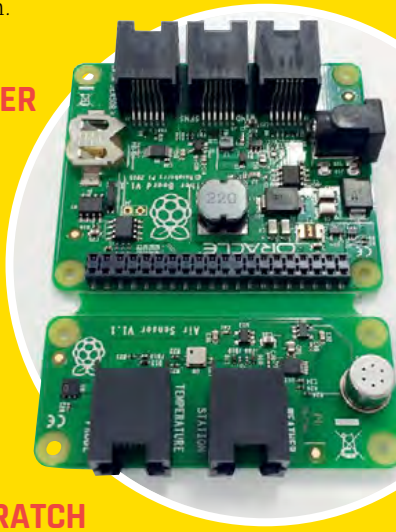
THREE WEATHER STATION PROJECTS

MAKE A WEATHER MAP

Even if you don't have a weather station, you can access the database of Pi Weather Station readings, and use it to plot temperatures on a map using Python.
magpi.cc/2sebENH

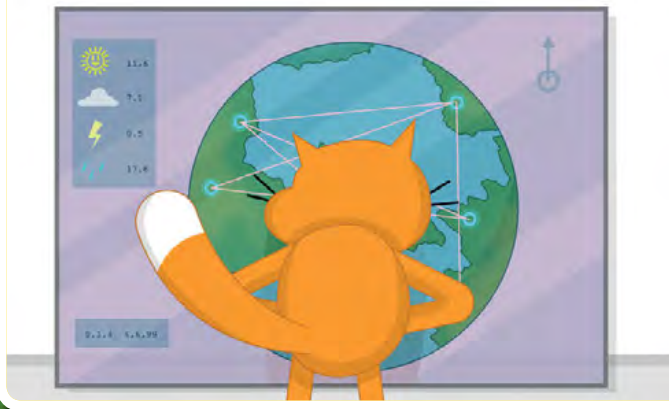
USE THE WEATHER STATION HAT

The official Weather Station HAT is being used by schools to record data, including humidity, pressure, and air quality readings, in an Oracle database.
magpi.cc/2tbMCvF



REPORT THE WEATHER IN SCRATCH

Use Scratch to display your weather data, including a thermometer, along with a visual indicator for wind speed and direction. A Python script is used to feed the data to Scratch.
magpi.cc/2ssQCLK



DAVE AKERMAN
Dave Akerman is a high-altitude balloonist who, in his spare time, is a self-employed software engineer working on PCs and embedded solutions.
daveakerman.com

LAUNCH A RASPBERRY PI BALLOON

Up, up and away: send your Pi sky high!

GET PERMISSION

Before flying your balloon in the UK, you need to request permission from the Civil Aviation Authority at least 28 days in advance. Avoid areas near airports and air shows, and send an email to confirm (or cancel) your plans a few days before launch. Outside the UK, try asking for advice on the #highaltitude IRC channel on Freenode.

Don't launch without permission: you might endanger aircraft.

As Neil Armstrong took a giant leap for mankind, he inspired one boy, watching at home, to send a bear into space.

As an adult, Dave Akerman launched Babbage on a high-altitude balloon with a camera, sending the teddy bear 39 km above the Earth. In a stunt that replicated Felix Baumgartner's record-breaking skydive, Babbage was released for a free fall.

"At that height, there's the slight curvature of the Earth, and the thin blue line of the atmosphere separating the ground below from the blackness of space above," says Dave. "On a clear day, with a wide-angle lens, I've had the whole of southern England from Cornwall to Kent in the same shot."

A high-altitude balloon (HAB) flight works like this: the balloon is filled with hydrogen so it rises at a speed of about 5 m/s. On the line between the payload and the balloon is a parachute, which is pulled closed during the ascent. After a typical flight of

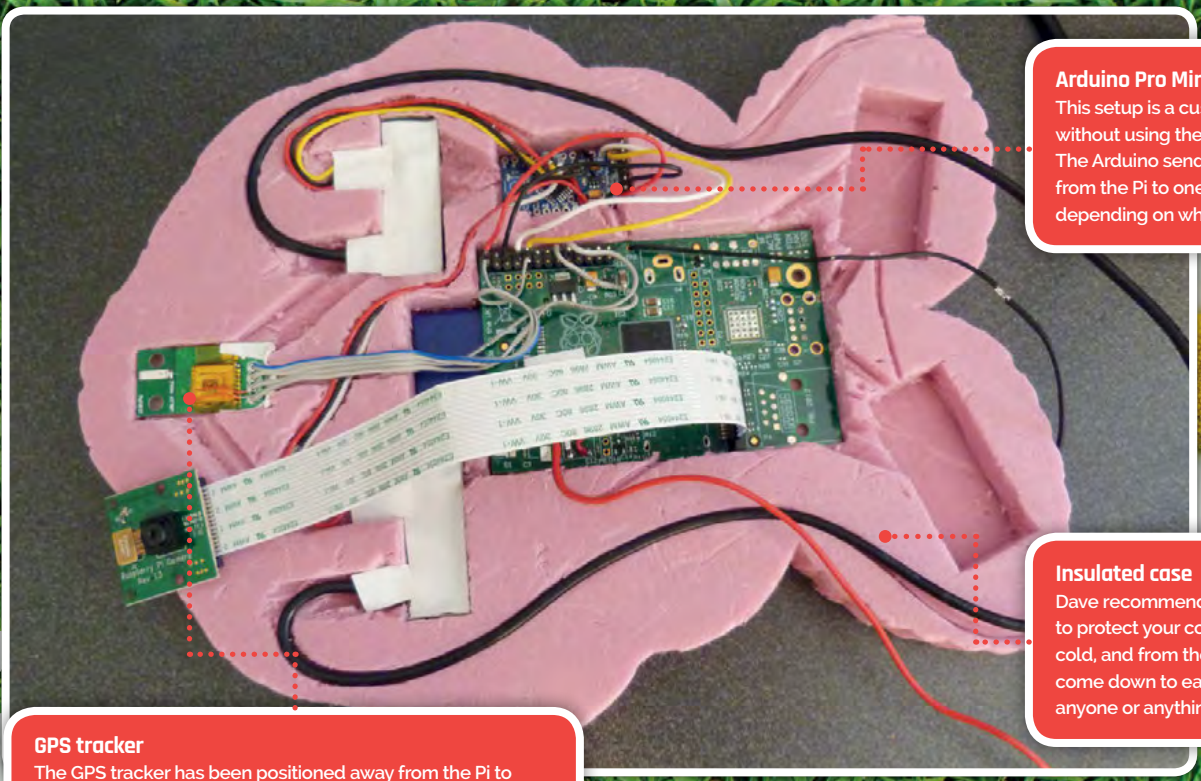
THREE THINGS YOU NEED TO BUILD A HIGH-ALTITUDE BALLOON

PI IN THE SKY KIT

You can build your own tracking system, but the simplest option is to use the Pi in the Sky kit, which includes the GPS antenna and a radio transmitter.
magpi.cc/2rablQk

CAMERA

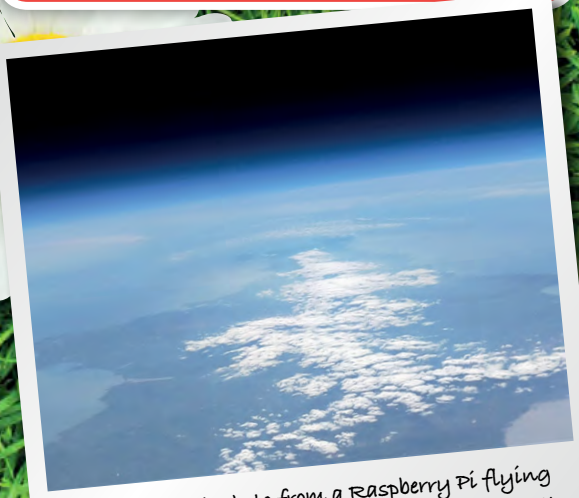
Using a Raspberry Pi with the Camera Module, you can program the camera to shoot at certain altitudes only. Don't use a case: it will trap moisture and ruin your images.
magpi.cc/28IjIsz



Arduino Pro Mini
This setup is a custom build, created without using the Pi in the Sky kit. The Arduino sends image data from the Pi to one of two radios, depending on which one is available.

Insulated case
Dave recommends plenty of insulation to protect your components from the cold, and from the impact when they come down to earth. It also protects anyone or anything your kit lands on!

GPS tracker
The GPS tracker has been positioned away from the Pi to provide a clear signal. Put your GPS aerial near the top of your container, and make sure it has an unobstructed view.



High-altitude photo from a Raspberry Pi flying over Swindon, looking over Devon and Cornwall

two to three hours, the balloon bursts at high altitude, and the payload drops. The parachute opens, and the payload returns to the ground. The payload includes a GPS tracker and a radio transmitter so you can follow its journey from the ground, and be ready to recover it. You can also receive images during the flight.

There are several options for the radio transmissions. Most people in the UK use RTTY (Radio Teletype) transmissions, but some also use LoRa, a proprietary long-range radio system that enables images to be downloaded more quickly. In some countries (but not the UK), APRS can be used, if you have an amateur radio licence.

"In the UK we have a widespread network of other hobbyists who will help during the flight, meaning that even if the chase car loses signal (e.g. it's in a tunnel or on the wrong side of a hill) then the rest of the receiver network will fill in the gaps," says Dave. Data from flights is fed into a distributed mapping system called Habhub. "With a well-tested radio tracker, the chance of not knowing where the payload has landed is pretty close to zero."

Dave started out building his own tracking and transmission systems, but the Pi in the Sky (PITS) kit can now do this for you. Among other things, it enables data from the Sense HAT to be sent back during the flight.

"Some of my flights have had a 3G link at low altitudes (useful for streaming video to YouTube), or have predicted their own landing position during descent," Dave says. "My current project is to use a gliding parachute or parafoil to land at a particular target location, using wind data measured during ascent to feed the guidance algorithm during descent."

Dave advises new launchers to read as much as they can to avoid mistakes others have already made. "Read the UK High Altitude Society website (**ukhas.org.uk**), read various HAB blogs, and join the #highaltitude IRC channel on Freenode and introduce yourself," he says. "Do all three!"

BALLOON

The balloon (shown here bursting) carries your payload. Use the online calculator to work out which size you need: typically 800 g or 1000 g, depending on the weight of your payload.
magpi.cc/2rRPZKr

10 GREAT OUTDOOR PROJECTS

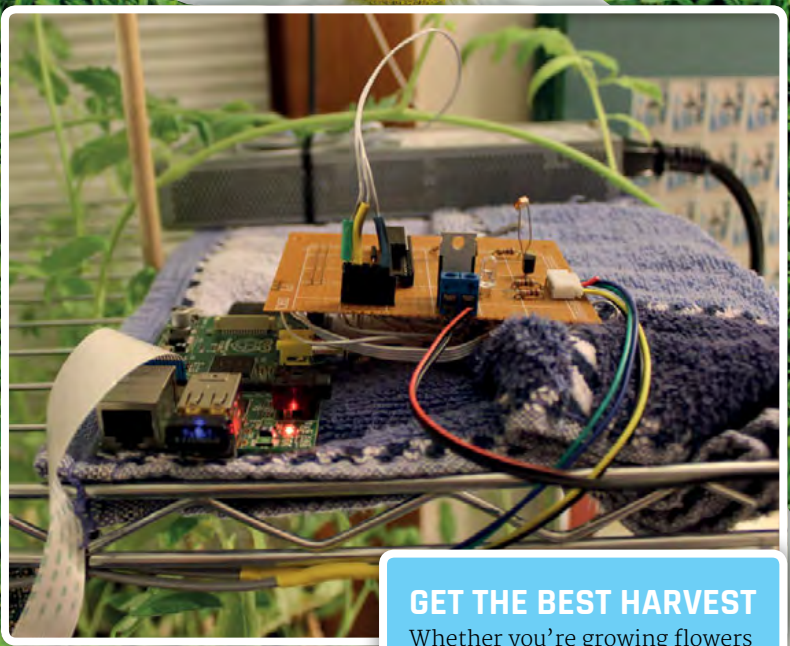
Get close to nature, pimp your ride, and see the world differently with these brilliant projects

Photo: David Schneider/IEEE Spectrum

SUPERSIZE YOUR BIKE COMPUTER

David Schneider replaced the tiny computer on his bike with a Kindle Touch. Reed switches on the wheel and chain ring are used to measure the speed and cadence. The Kindle browser displays the stats, which a GPS-equipped Pi in the saddlebag uploads to a webpage.

magpi.cc/2tcc8ky



GET THE BEST HARVEST

Whether you're growing flowers or veg, Devon Bray's PiPlanter project can help. It automates watering, based on a schedule or soil moisture levels. It also monitors light and temperature, and creates a time-lapse video. Relax on holiday, knowing the plants are cared for, and watch their progress on Twitter.

magpi.cc/2seoFqx

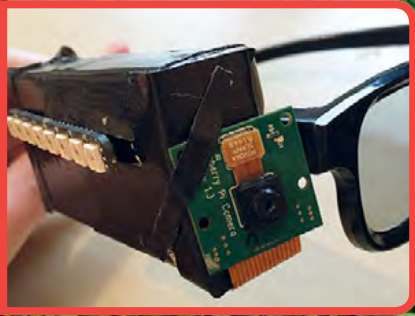
BUILD A MINIBEAST HABITAT

Invite snails or your favourite insects to move into a new home. Computing teacher Allen Heard and his son Lincoln made a Minecraft-themed minibeast habitat from a cereal box. A webcam connected to a Raspberry Pi streams video to the iCamViewer iOS app.

magpi.cc/2stfDq6

BUILD A WEARABLE CAMERA

With these glasses, you can capture everything you see, automatically taking a photo every 30 seconds. A Raspberry Pi Zero inside the box controls a Camera Module, and an optional Blinkt! module flashes when a shot is taken. Cherry-pick your best shots, or turn them all into a film.
magpi.cc/2rhBbl6

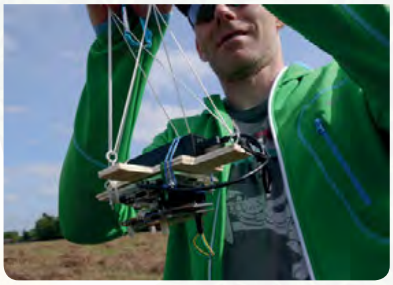


WATCH THE WILDLIFE

Photograph passing squirrels, woodpeckers, and partridges with the Naturebytes Wildlife Camera Kit (see our review in issue 48). It uses a movement sensor to snap pictures of passing birds and animals, and has a green case so it blends in with your foliage.
naturebytes.org

FLY A KITE

Want a cheaper way to take aerial photos? Richard Hayler sent a Raspberry Pi up on a kite. He used the Xtrinsic Sensor Board to measure altitude, the Camera Module to take photos, and **mapknitter.org** to combine the aerial shots. At maximum resolution with image stabilisation, the photos look great.
magpi.cc/2s26F0a



BROADCAST BIG BROTHER FOR BIRDS

Discover the secret life of birds, with this project to add an infrared camera to a bird box. When the blue tits move in, the Pi NoIR Camera Module can video them in black and white, by the light of an infrared LED. You can then stream your footage to YouTube.
magpi.cc/2c8P2rr

TAKE YOUR PI ANYWHERE

The Zero LiPo device (see our review in issue 51) enables you to safely power your Raspberry Pi from a battery pack (sold separately). Despite the name, it works with the Raspberry Pi 3, 2, B+, A+, Zero, and Zero W. What will you make with a portable Pi?
magpi.cc/2coJyZ2

MAKE SPINNING FLOWERS

If the weather forces you into the great indoors, you can bring nature inside by making your own spinning flowers. Use the Explorer HAT with a motor and mount your own flower design on the wheel. The code is in Python, and this makes a great first motor project.
magpi.cc/2ralmNy

MOTORISE YOUR SKATEBOARD

Put some zip into your trips around town with an electric skateboard. YouTuber TheRaspberryPiGuy used a Raspberry Pi Zero to control an Alien Power System motor, and a Wii Remote to control the speed and acceleration over Bluetooth. He hit speeds as fast as 30 km/h, and he says the range is at least 10 km.
magpi.cc/2oyuWrU

magpi.cc/2t5PA5y

£40 / $50

OCTOCAM

A complete camera kit with a fun design

The latest in Pimoroni's growing range of Pi Zero W project kits, OctoCam provides everything you need to build your own cute camera. As with the other Pimoroni kits, the packaging is excellent and the hinged plastic case can be reused to store other components afterwards.

Inside the box you'll find a Raspberry Pi Zero W, a 5 MP mini camera (more on this later), and an octopus-shaped acrylic mount with four suction cups and a desk stand. The only things you need to add are a microSD card and a power supply. Bonus components in the box include USB and HDMI adapters for the Pi Zero W, along with a 50 cm USB to micro USB cable, a male 2×20-pin header (to solder on), and a sticker sheet.

Assembly of the main camera kit takes around 30 minutes using a step-by-step guide (**magpi.cc/2srIv2q**) and is fairly straightforward, if a little fiddly at times. This is mainly due to the tiny nylon nuts, bolts and spacers,

Related

ZEROVIEW

A neat custom mount for the Raspberry Pi Zero and official Camera Module, which can be stuck to a window using its two suction cups.

£7 / $9

magpi.cc/2e89hWt

Third-party camera

Designed for small projects where space is at a premium, the mini camera unit in the OctoCam kit is an unofficial device, but features the same 5 MP sensor as the original v1 Raspberry Pi Camera Module. Specs include a maximum 2592 × 1944 resolution for stills, and 1080p video at 30 fps. It's also available separately (magpi.cc/2t1l50S), including a version without the IR filter, which you could to use in the OctoCam to make a night-vision camera.

Maker Says

"A cute, connected, cephalopod camera to stick on your window or sit on your shelf!"

Pimoroni

one of which we managed to drop on the floor! These fixtures secure the Raspberry Pi Zero W to the mount while keeping it far enough away from the camera to protect the latter from overheating. We found it a little tricky to keep the camera lens in the mount hole while folding over its short cable to position the Pi, but it was still a lot easier than the cable-twisting shenanigans involved when assembling the rival ZeroView camera mount. The optional desk stand is easily added, enabling you to sit the OctoCam on a shelf.

Mini camera unit

The camera itself is a third-party model (also available separately) with compact dimensions (60×11.4×5.1 mm). Some of the electronics are located on its flexible cable, so the end with the camera lens is a lot smaller than that of the official Raspberry Pi Camera Module. As it uses the same 5 MP sensor as the original v1 official Camera Module, it has similar specs and works straight out of the box, once you've enabled the camera in **raspi-config** on the Pi. You can use the standard **raspistill** and **raspivid** commands in a Terminal window, or by SSHing in from a remote computer.

The quality of the images is very good, as are captured videos (lacking sound, of course). Sticking the OctoCam to a window, we soon managed to capture a nice time-lapse of the setting sun – although we ended up stitching the images together on another computer, as it's a bit too much for the Pi Zero W to handle.

Another obvious use for the OctoCam is as a CCTV security camera, using the motionEye OS operating system. Pimoroni's online tutorial (**magpi.cc/2srz9n6**) shows how to set this up, including preconfiguring the wireless connection – you'll need to do this instead of starting with a wired connection to the router, as the Zero lacks an Ethernet port. We found the frame rate pretty low (2–3 fps) at anything but the lowest resolutions when using motion detection, dipping even lower when it started recording video. This appears to be due to the limitations of the Pi Zero and/or software, rather than the camera, as we discovered when we tried using a v2 Camera Module instead. Fortunately, if you just want to stream live video, turning off the motion detection (by activating the Fast Network Camera option) results in a decent frame rate.

Above The OctoCam's suckers stick it securely to a window

Last word

With its compact dimensions and fun design, the OctoCam is very appealing. The third-party camera unit performs well, although the whole setup struggles to handle motion detection and recording in motionEye OS. It's also a little expensive, considering that you could buy a Pi Zero W and the standalone mini camera for under £24. Sure, you get a few extras in the box along with the mount, but you might not want them all.

★★★★☆

WEB BROWSER GROUP TEST

What is the best way to surf the World Wide Web in Raspbian?

It is hard to overstate the importance of web browsers and how much we take them for granted. They are our access point to a universe of information, and they do a lot of work to bring us all this information in a readable format.

Raspbian has featured several default web browsers over the last five years, changing as internet access and power requirements have developed. Is the latest choice, Chromium, the best of the lot? We test some of the best browsers available to find out.

The MagPi
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MIDORI

The original Raspbian web browser, well known as a lightweight browser for the Linux community, is suitable for use on a (relatively) low-powered system. It hasn't been included in standard Raspbian releases since around the time of the Raspberry Pi 2 launch, so we went into testing Midori on our Pi 3 expecting it to outperform everything else.

Unfortunately, we were surprised to find it lagging as we used it. YouTube videos stuttered, and scrolling was only smooth on low-resource websites such as Wikipedia. Loading wasn't particularly fast either. The lack of features, which should have made it fast and lightweight, did not seem to help, and this gave it a severe handicap.

midori-browser.org

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EPIPHANY/WEB

As with Midori, we had high expectations looking back at Epiphany. Known as Web in the GNOME desktop environment, it's an often-overlooked browser that is usually singled out for being far too simplistic and basic.

Like Midori, it was once a default Raspbian browser, with a modified version used until recently when it was superseded by Chromium. Unlike Midori, it is optimised for use with the Raspberry Pi.

We expected our revisit to Epiphany would reaffirm our dislike for it, but honestly it still works well on the Raspberry Pi. Scrolling is relatively smooth, YouTube playback is fine, and juggling tabs is easy. It's still heavily limited in what it can do, but it did a lot better than we expected.

magpi.cc/2rUHrmX

CHROMIUM

The current default browser for Raspbian, Chromium is the open-source base of Google's Chrome browser. There's not a lot of difference between the two, especially as Raspbian's version has Flash installed.

On a normal PC, Chromium is relatively lightweight (especially if you're using only a few tabs at a time), but even this slimmed-down version of Chromium for Raspbian offers good performance. The Raspberry Pi 3 has the power to handle it, and with enough oomph spare to run other software.

One of the benefits of running Chromium is that it also connects to your Google account. If you use Chrome or Chromium on your main PC, it lets you instantly copy over settings and apps, so it is easier to set up the browser to your liking.

chromium.org

FIREFOX ESR

There's a bit of weird history behind Firefox on Debian (the base of Raspbian), but the important thing is that it's here now, and it's in the form of an ESR.

ESRs are Extended Support Releases, slightly different to the main version of Firefox. Firefox usually updates every six weeks or so, but this version is sent security updates only until the next set of major updates arrives.

We were pleasantly surprised by the way Firefox worked on the Raspberry Pi 3. It loaded quickly, rendered pages well, allowed for smooth scrolling, and even played YouTube videos well; but what made it shine was one of its lesser-known features: book reader mode.

Book reader mode takes a blog-style post and strips the formatting down to a page with plain text and pictures. It reduces resource use considerably and works well with a Raspberry Pi, especially when you're looking up tutorials or instructions.

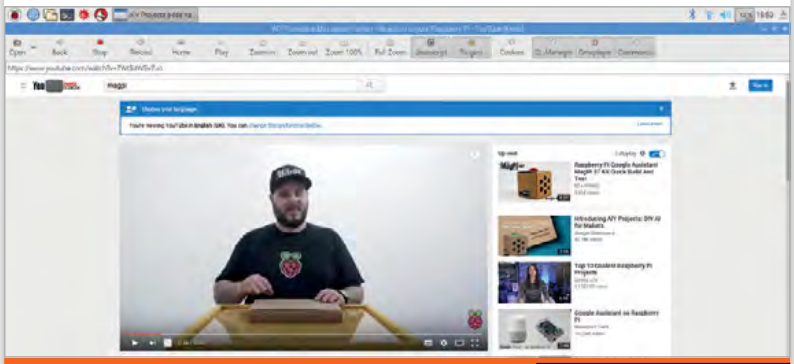
mozilla.org/firefox

KWEB

This is the only browser in this selection that has been made specifically for Raspbian, and in fact goes beyond the definition of a web browser: kweb is designed to be part of a Raspberry Pi-powered web kiosk.

Don't let that deter you though, as it's still well suited to standard web browsing. For people who are a bit more web savvy, kweb offers a range of options to customise your web browsing experience for maximum efficiency. This includes a button on the main interface that lets you turn certain features on and off, such as JavaScript, cookies, and more.

While it can be lightning fast, you do sacrifice many of the amenities of modern browsers to produce this great performance.



magpi.cc/2rUZGbM

AWARDS

WINNER CHROMIUM

MOST SURPRISING FIREFOX ESR

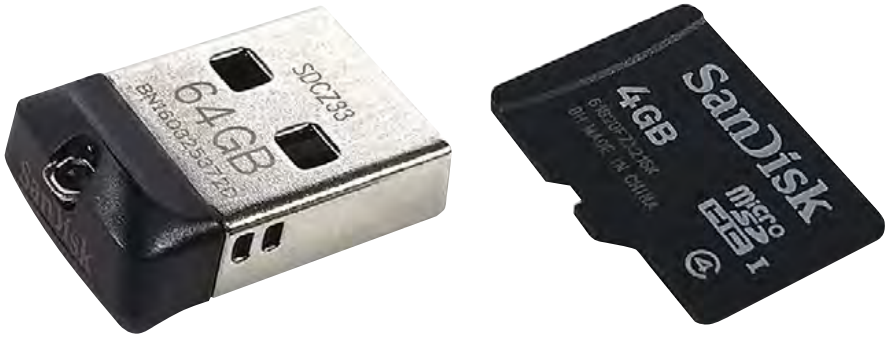
magpi.cc/2pJjBpT

£19 / $19

Maker Says

"The ideal storage solution for Raspberry Pi"

WDLabs



WD PIDRIVE FOUNDATION EDITION - USB FLASH

Tag-team a microSD card with a USB flash dongle for extra storage. Lucy Hattersley looks at WD's latest offering

WDLabs has produced some quirky and interesting storage solutions for the Raspberry Pi recently.

The idea is simple: WDLabs has built a custom version of Raspbian that boots to an external storage drive. This external storage space then acts as the primary drive, so you only have to manage one single storage space.

There are other bonuses to WDLabs' software: you can install multiple instances of Raspbian OS alongside other OSes.

When WD bundles a 4GB microSD card with one of its large (250GB or 375GB) hard drives, the advantage is clear. You get a much bigger storage space than would be possible with microSD card technology. However, what we have here is a microSD card bundled with a SanDisk Cruzer 64GB USB drive, so things are a little muddier.

For example, you can pick up a SanDisk 64GB microSD card for around the same £20 price. You could keep a USB port free on your Raspberry Pi and get a more straightforward installation.

What you do get, however, is a high-quality microSD card and a high-quality USB drive. And USB drives are typically faster than microSD cards (which vary in read and write speed tremendously – this is why you should choose a Class 6 or Class 10 microSD card from a trusted brand, like SanDisk). Even so, we expected the USB thumb drive to be faster, and benchmarks didn't let us down.

Benchmarks

We benchmarked the WD PiDrive Foundation Edition, USB Flash (sda) against an official 8GB Raspberry Pi microSD card (mmblko).

As you can see below, the USB Flash read was marginally slower with cached reads, but almost a third faster in buffered disk reads. On balance, you are getting more speed for the same money.

	TIMING CACHED READS:	TIMING BUFFERED DISK READS:
/dev/sda	1118 MB in 2.00 seconds = 558.75 MB/sec	100 MB in 3.01 seconds = 33.21 MB/sec
/dev/mmcblk0	1140 MB in 2.00 seconds = 570.02 MB/sec	64 MB in 3.02 seconds = 21.19 MB/sec

Last word

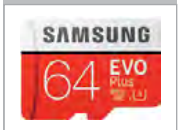
The WD PiDrive Foundation Edition, USB Flash is a good setup for a media centre or retro games console. It offers fast read times and more storage than a stock card. While it's not quite as impressive as the other WD PiDrive offerings, it's still a useful piece of kit.

★★★★☆

Related

SAMSUNG 64GB EVO PLUS

You can pick up a high-quality microSD card with about the same amount of storage space for roughly the same price.



£22 / $29

magpi.cc/2rDv5v3

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RASPBERRY PI BESTSELLERS

BERRETT-KOEHLER

Hit a roadblock in your maker project or business? BK have the answers.

EAT THAT FROG!

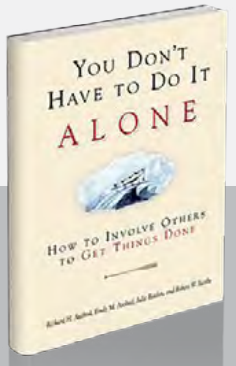
Author: Brian Tracy
Publisher: Berrett-Koehler
Price: £11.99
ISBN: 978-1626569416
magpi.cc/2s38ZE8

INTERNATIONAL BESTSELLER
EAT THAT FROG!
21 GREAT WAYS TO STOP PROCRASTINATING AND GET MORE DONE IN LESS TIME
BRIAN TRACY

Working hard without results? Fighting creative blockage, and suffering from procrastination? Tracy cuts through the clutter and gives you simple tools to complete your projects. Take back control!

YOU DON'T HAVE TO DO IT ALONE: HOW TO INVOLVE OTHERS TO GET THINGS DONE

Author: Dick Axelrod et al.
Publisher: Berrett-Koehler
Price: £16.99
ISBN: 978-1576752784
magpi.cc/2s2W992



From bug fixing and testing through to crowdfunding, makers need others. From intrapreneurs, through side projects, to startup maker businesses, Axelrod et al. will help you to get the right people involved.

DON'T JUST DO SOMETHING, STAND THERE!

Authors: Marvin Weisbord, Sandra Janoff
Publisher: Berrett-Koehler
Price: £16.50
ISBN: 978-1576754252
magpi.cc/2rj5Blh

Don't Just Do Something, Stand There!
Ten Principles for Leading Meetings That Matter
By Marvin Weisbord and Sandra Janoff

Getting results is often hindered by being in a room (or worse, a virtual environment) with people who don't understand your aims, and are hard for you to get a handle on. Change your approach.

THE INTERNET OF RISKY THINGS

Author: Sean Smith
Publisher: O'Reilly
Price: £23.99
ISBN: 978-1491963623
magpi.cc/2rSCfPE

You can bury your head in the sand – or you can read this book. IoT devices are already permeating every aspect of our lives, yet the usual IT business excuses have left a vast installed base of unpatched and unpatchable software in devices we can barely even access, or have forgotten about entirely.

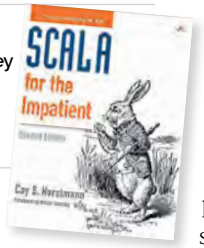
Forever-day exploits are zero-day exploits that remain permanent for several years (or indefinitely). Patches are released, but who patches their ADSL router? Or their coffee machine? Sean Smith outlines the very real risks we're taking with the rush to connect every possible device to the internet – medical devices, cars, the power grid – and our Panglossian disregard for the downsides.

Blunders ('anti-patterns'), including those from traditional internet-connected computer devices, are outlined, with truly scary examples of connected devices' vulnerabilities from recent years, and the case made for a more robust and systematic approach by manufacturers. Identity and trust, devices that outlive their cryptography, privacy cautions, business cases pulling in different directions from security cases: every angle is carefully considered – including law, the digital divide, and future human-machine relationships – but Smith gives no glib answers to the many questions and reflections. The beginning of a very necessary conversation.

Score ★★★★☆

SCALA FOR THE IMPATIENT

Author: Cay S Horstmann
Publisher: Addison-Wesley
Price: £27.99
ISBN: 978-0134540566
magpi.cc/22tPmUY



Another month, another new edition of a Horstmann classic: this time the introduction to Scala written to save readers from working through the comprehensive but 800-page guide from language creator Martin Odersky. Following Odersky's conventions, chapters and subsections are classified by level for application and library developers, and difficult sections can be skipped by the truly impatient Scala learner.

Scala is a statically typed JVM language, more expressive and powerful than Java, with good concurrency; maintaining full OO abilities, while adding in functional programming – and not as a bolt-on afterthought. Scala has obvious appeal for modern enterprise projects with large codebases, and Horstmann's tutorial will quickly bring Java or C++ (and C#) coders to appreciate its possibilities. Scala has many other applications, from web programming to newer paradigms such as probabilistic programming.

Since the first edition, there have been several other books on Scala, but Horstmann's strengths – clarity, concision, and plenty of timely cautions about potential problems – combine with the latest on futures, concurrency, and implicit conversion of types, to make this a good choice for readers with a Java or C++ background. Brief but strong introductions on topics like pattern matching, and on annotations, add to the book's appeal.

Score ★★★★☆

PRO PYTHON BEST PRACTICES

Author: Kristian Rother
Publisher: Apress
Price: £14.99
ISBN: 978-1484222409
magpi.cc/2tdxRbY

As your Python programs grow, so do your problems: debugging gets harder; the need for well-written tests becomes more urgent; and maintenance issues intrude; bringing the need for a better approach to version control, code organisation, and documentation. *Pro Python Best Practices* is a neat exploration of all of these topics, which starts by making the case for best practices. Here Rother compares and contrasts the approaches of hacking, software engineering, agile, and software craftsmanship, coming down in favour of the last.

Craftsmanship emphasises purpose, planning, tools, skills, community, and practice. Tools come to the fore in debugging, but so too does the scientific method.

This section sees the introduction of a maze runner program, used throughout the book as the test bed for the methods, tools, and techniques taught.

The automated testing section is a valuable introduction to a topic that many newer programmers put off learning. Starting simply with writing and running test functions with pytest, Rother soon builds through complex border cases to more diverse test data, and then to writing a complete test suite. Maintenance runs through project structure and refactoring, to approaches like defensive programming to prevent the unchecked propagation of errors allowed by dynamic typing. Essential material.

Score ★★★★★

COMPUTERS AND GAMES

Editors: Aske Plaat, Walter Kosters, Jaap van den Herik
Publisher: Springer
Price: £37.99
ISBN: 978-3319509341
magpi.cc/2rbgRlG

AI research and the game of Go came to the public's attention recently when Google's AlphaGo program beat the world's number one human player. Its combination of move finding by Monte Carlo Tree Search (MCTS) and Neural Networks is the pinnacle of a huge amount of AI research, particularly in the field of game playing. This collection of 20 academic papers from last year's international Computers and Games conference, useful reading for any curious reader, covers these topics and more.

MCTS dominates, including the opening 'Using Partial Tablebases in Breakthrough', which applies Deep Convolutional Neural Networks to MCTS for huge improvements in playing strength. Winning the Best Paper Award at the conference, Lorentz and Isaac's research concludes with promising strategies for further refinements.

We also find novel strategies and games modelling in Werewolf, temporal difference learning in 2048, and Nash Equilibrium for better code-making choices in Mastermind. A few papers require some undergraduate maths (yours via various MOOCs), and things get a little more theoretical in the penultimate section. The final section contains a single paper which asks 'Do People Think Like Computers?', and combines AI and behavioural science work for a better understanding of human behaviour and approaches in adversarial combinatorial games like Go.

Score ★★★★☆

ESSENTIAL READING: MODERN PROGRAMMING PARADIGMS

Beyond OO and FP, coders need to be aware of reactive patterns, good APIs, and more.

Irresistible APIs

Author: Kirsten L Hunter
Publisher: Manning
Price: £27.99
ISBN: 978-1617292552
magpi.cc/2rnXCoi

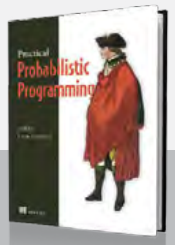
Work across organisations to 'Create Web APIs That Make Your Developers Weep (For Joy!)', backed by a strong business case.

Functional Reactive Programming

Authors: Anthony Jones, Stephen Blackheath
Publisher: Manning
Price: £27.99
ISBN: 978-1633430105
magpi.cc/2rnzSkl

FRP intro for Java and JS programmers, which should help those still baffled by functional programming.

Practical Probabilistic Programming



Author: Avi Pfeffer
Publisher: Manning
Price: £36.99
ISBN: 978-1617292330
magpi.cc/2rSPHD8

No abstract concept, but a practical, predictive paradigm with strong ML applications, from spam filtering to data and image recovery.

Reactive Design Patterns

Author: Roland Kuhn
Publisher: Manning
Price: £27.99
ISBN: 978-1617291807
magpi.cc/2sUFV1C

Reactive Manifesto co-author and Akka lead Kuhn brings message-driven enlightenment in logical steps.

Visualizing Graph Data

Author: Corey L Lanum
Publisher: Manning
Price: £24.99
ISBN: 978-1617293078
magpi.cc/2rjcdX8

Organise and present data in graph format, highlighting relationships in data, and change the questions you ask of the data.

THE MONTH IN RASPBERRY PI

Everything else that happened this month in the world of Raspberry Pi

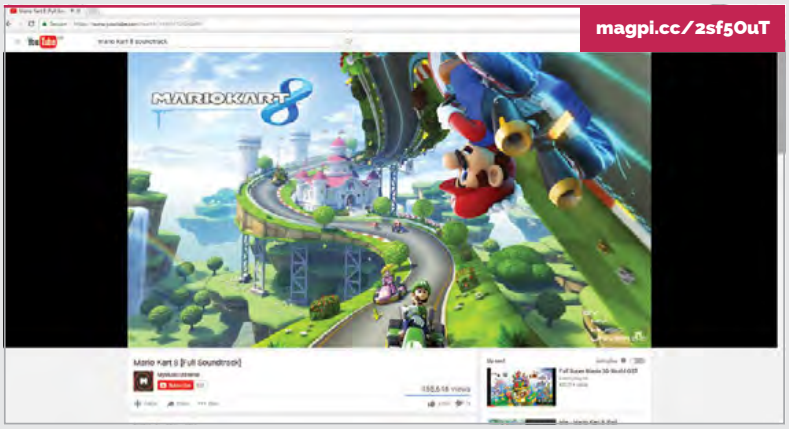
MORE AIY PROJECTS!

People love the AIY Projects voice kit – here's some of the excellent stuff they've been making

It's been a couple of months since we released issue 57 with the Google AIY Projects voice kit, and we're still seeing people make awesome stuff with it. One of our favourite websites during that time has been the Ktinkerer page (**magpi.cc/2sJlZ52**), which lists a lot of the cool mods they've come across. Here are some of our faves...

MUSIC

A lot of people have asked us whether AIY can connect to Google Music. Some clever people have worked out how to make it work



PLAY MUSIC FROM YOUTUBE

We do this on our PCs sometimes – just have a soundtrack playing via YouTube while we work. With this mod, you can add this functionality to the AIY kit! You don't even have to preset any videos: it will automatically pick one for you.

GOOGLE MUSIC

Google with Google should be a natural pairing, so this mod that lets you play music via Google Music on your AIY kit is cool. This version also includes a little scrolling marquee (using the Scroll pHAT) showing the name of the current song!

BBC RADIO

Add the ability to listen to any of the major BBC Radio services via the internet. This mod uses VLC, which is the established method. There's even a workaround for people wanting to listen to the BBC outside the UK!

BASIC COMMANDS

Some basics that people have added to their AIY Projects boxes

magpi.cc/2rJTfnP

ADD REBOOT AND SHUTDOWN COMMANDS

So good that Google has merged it into the main AIY Projects repo, this command lets you reboot by saying "pi reboot", and lets you shut it down with "pi power off". Nice, simple, and you can add it yourself.

magpi.cc/2rJu0lM

ADD A TIMER

One of the great things about a smartwatch is being able to set a timer without having to dig your phone out. This feature isn't in the AIY code, so this mod lets you add it. Smart!

magpi.cc/2rJBOE7

SHUT DOWN WITH SELF-DESTRUCT

Shut down with a twist. You can ask the AIY Pi to turn itself off, or you can have it count down to turning it off by asking it to initiate self-destruct. It obviously doesn't actually destroy itself, but you know... it's fun.

BUY AIY PROJECTS KIT

Wanted to get a copy of issue 57 and the AIY Projects voice kit, but found they were sold out? We hope to see more kits in the near future, and you can sign up to our mailing list to find out when they will be available at **magpi.cc/Email-me**.

BEST OF THE REST

Here are some other fun mods for the AIY Projects kit

magpi.cc/2sf7rcc

AMAZON DASH TRIGGERS

Adding triggers to the AIY kit is a good way to expand what it does. This allows you to activate the voice assistant by saying "OK Google", rather than using the button. This mod goes one step further and adds additional buttons to the kit.

magpi.cc/2sfb9m1

REMOTE-CONTROL 433 MHZ SOCKETS

Home automation is great, especially when you can make it work using voice activation, just like *Star Trek*. This project lets you hack some 433 MHz sockets with your AIY kit to do just that.

magpi.cc/2sePqdZ

VOICE CHESS

Play chess against the computer using only your voice. You may need to lay out a real chess board if you can't visualise the game in your head. At least you'll be prepared to answer a chess move riddle so you can be beamed aboard the USS Enterprise.

Image credit ESA

EURO ASTRO PI COMPLETE!

The European Astro Pi competition is over, and the coders have the results of their experiements

We'll have a lot more about this in future issues of The MagPi, but we're really happy to report that the second Astro Pi competition has come to an end. French ESA astronaut Thomas Pesquet looked after the Astro Pi units on board the space station and kept an eye on the experiments as well – all 64 of them!

> "We can see that many of the teams have been successful in their missions"

On 10 May, all the results were beamed back to Earth, and the various student teams received them a week later to analyse and release in their own time.

"We've looked at the results," Astro Pi organiser Dave Honess wrote on the Raspberry Pi blog (**magpi.cc/2sft24g**). "We can see that many of the teams have been successful in their missions: congratulations to all of you! We look forward to reading your write-ups and blogs."

We'll show off some of the cool experiment results in future issues, but for now here are some pictures from the competition.

Here we have the experiments from Astro Team (Italy, left) and AstroShot (Greece, right). Image credit ESA

EXPÉRIENCE PÉDAGOGIQUE | À Saint-André-d'Embrun (Hautes-Alpes), des élèves travaillent pour l'ISS

Nom de code : Thomas Pesquet

The end of the experiment made the French papers!

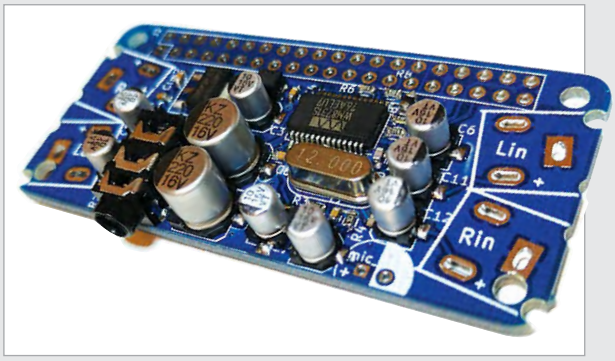
KICKSTART THIS!

Raspberry Pi projects you can crowdfund this month

STAND FOR OFFICIAL TOUCH SCREEN

kck.st/2qG7SJi

This is a simple yet cool little Kickstarter project – a stand specially made to hold the official touchscreen, along with a Raspberry Pi. It is designed to be easy to assemble, and would look great as a specialised recipe computer in your kitchen, or for showing videos at events and shows. There's even room to add a HAT!



AUDIO INJECTOR ZERO

kck.st/2su4LED

Another Raspberry Pi sound card, this one is a Zero-sized version of the previous Audio Injector for other Raspberry Pi models. You can even solder on an electret microphone if you wish! The stretch goals determine what's going to be on the board, so you can help determine how the final product turns out. It's a high-quality audio add-on for the Pi, so if you enjoy good audio it's definitely worth a look.

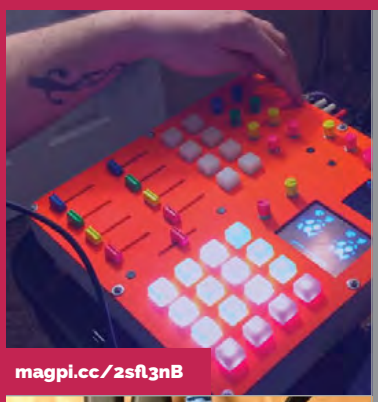
BEST OF THE REST

Here are some other great things we saw this month

magpi.cc/2rwmSKf

MINI SNES

Waiting for the official Nintendo SNES Classic Mini? Andrew Bougie made his own 3D-printed SNES case for the Raspberry Pi, and shared the design files on Thingiverse. It's probably much smaller than the official version would be – if only it wasn't the ugly American model...



magpi.cc/2sfl3nB

magpi.cc/2sf4lEW

RASPBERRY PI LOOPER/SYNTH/ DRUM MACHINE

This is super-awesome. A fully custom synth machine using a Raspberry Pi, full of all the switches and knobs you'd need to... synthesize music? Musical instruments have never been our strong point, but we want to play with this.

THE WORST CASE EVER MADE

We're not sure whether this is supposed to be bad because fitting it into an Atari 2600 cartridge was a bad idea, or because it's in a cartridge of the ET game. We'll leave that up for you to decide.

COMMUNITY PROFILE

ESTEFANNIE EXPLAINS IT ALL

From automated gingerbread houses to French press coffee at the touch of a button, **Estefannie** is taking the YouTube maker community by storm

Estefannie

Category: YouTuber

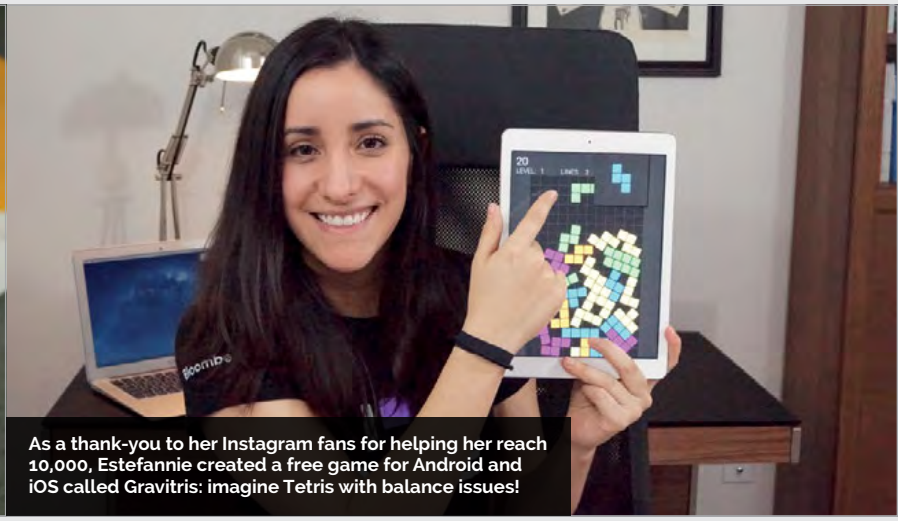
Day job: Software engineer

Web: magpi.cc/2sm6D5Z
estefannie.com
twitter.com/estefanniegg

"Hey, world!" Estefannie exclaims, a wide grin across her face as the camera begins to roll for another YouTube tutorial video. With a growing number of followers, and wonderful support from her fans, Estefannie is building a solid reputation as an online maker, creating unique, fun content accessible to all. It's as if she was born into performing and making for an audience, but this fun, enjoyable journey to social media stardom came not from a desire to be in front of the camera, but rather as a unique approach to her own learning. While studying, Estefannie decided the best way to confirm her knowledge of a subject was to create an educational video explaining it. If she could teach a topic successfully, she knew she'd retained the information. And so her YouTube channel, Estefannie Explains It All, came into being.

But YouTube isn't her only outlet. With nearly 30,000 followers, Estefannie's Instagram (**magpi.cc/2smasrZ**) game is strong, adding to an increasing number of female coders taking to the platform. Across her Instagram grid you'll find insights into her daily routine, from programming on location for work, to behind-the-scenes troubleshooting as she begins to create another tutorial video. It's hard work, with content creation for both Instagram and YouTube forever on her mind as

Below Her first videos featured pages of notes with voice-over explanations of data structure and algorithm analysis; then she moved in front of the camera, and expanded her skills in the process

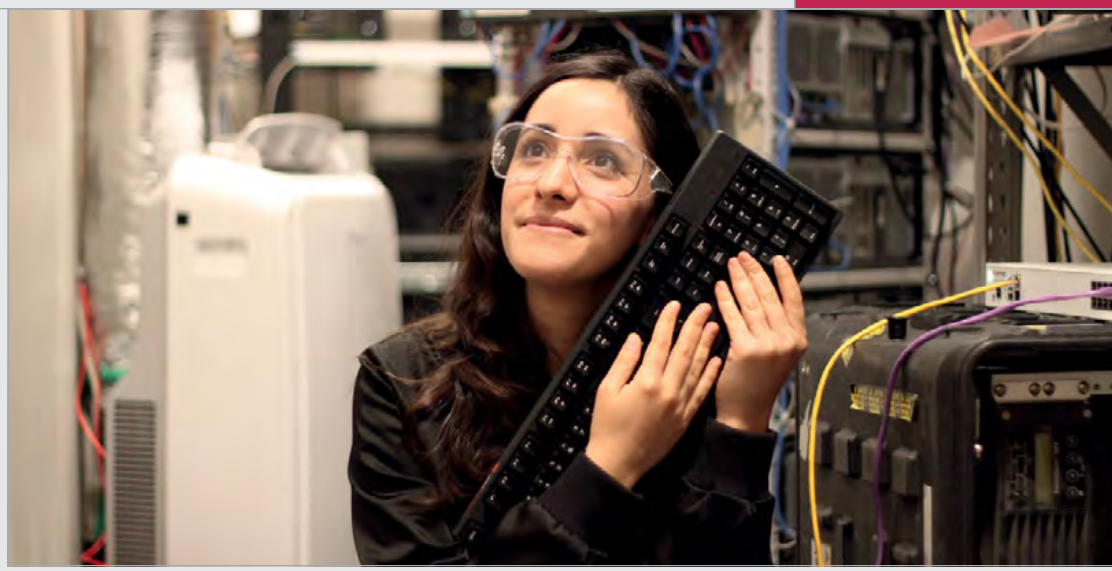


As a thank-you to her Instagram fans for helping her reach 10,000, Estefannie created a free game for Android and iOS called Gravitris: imagine Tetris with balance issues!

she continues to work and progress successfully as a software engineer.

Estefannie was born and raised in Mexico with ambitions to become a graphic designer and animator. However, a documentary on coding at Pixar, and the beauty of Merida's hair in *Brave*, opened her mind to the opportunities for software engineering in animation. She altered her career path, moved to the United States, and switched to a Computer Science course.

While studying, Estefannie started a Computer Science Girls Club at the University of Houston, Texas, and found herself eager to put more time and effort into the movement to increase the percentage of women in the industry. The club was a success, and still is to this day.



Above With a constant desire to make and to learn, Estefannie combines her software engineering profession with her hobby to create fun, exciting content for YouTube

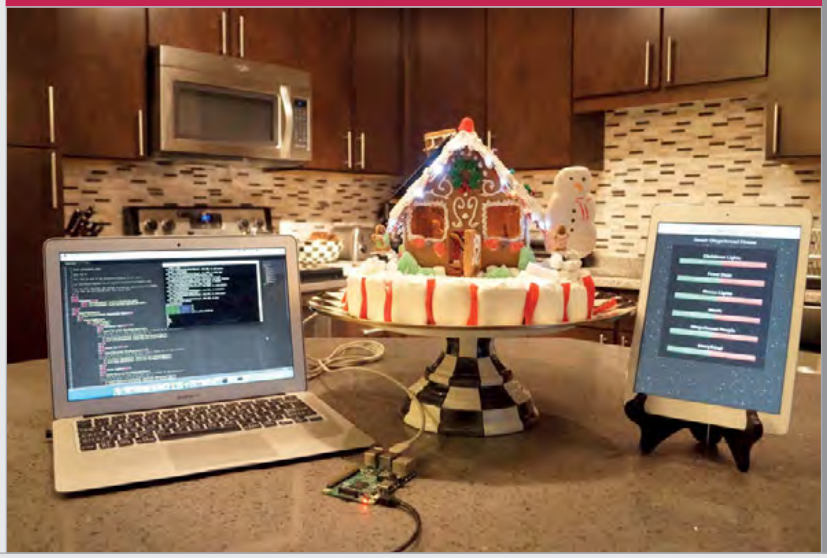
> "Estefannie's videos are essentially a documentary of her own learning process"

While Estefannie has handed over the reins, she's still very involved in the cause.

Through her YouTube videos, Estefannie continues the theme of inclusion, with every project offering a warm sense of approachability for all, regardless of age, gender or skill. From exploring Scratch and Makey Makey with her young niece and nephew, to creating her own Disney 'Made with Magic' backpack for a trip to Disney World, Florida, Estefannie's videos are essentially a documentary of her own learning process; produced so the viewer can learn with her – and learn from her mistakes – to create their own tech wonders. Using the Raspberry Pi, she's been able to broaden her skills and, in turn, her projects, creating a home-automated gingerbread house at Christmas, and an internet-button-controlled French press. And that's just the beginning of her adventures with Pi… but we won't spoil her future plans by telling you what's coming next. Sorry.

While many wonderful maker videos show off a project without much explanation, or expect a certain level of skill from the viewer who hopes to recreate the project, Estefannie's videos exist almost within their own category. We can't wait to see where Estefannie Explains It All goes next!

HIGHLIGHT



magpi.cc/2smk0mL

GINGERBREAD HOME AUTOMATION

Estefannie's automated gingerbread house project was a labour of love, with electronics, wires and candy strewn across both her living room and kitchen for weeks before completion. While she is a skilled programmer, the world of physical digital making was still a fairly new concept for Estefannie. Having ditched her hot glue gun in favour of a soldering iron in a previous video, she continued to experiment and try out new, interesting techniques that are now second nature to so many members of the maker community. With the gingerbread house, Estefannie was able to research and apply techniques such as light controls, servos and app making, although the latter was already firmly within her skill set. The result? A fun video of ups and downs that resulted in a wonderful, festive treat. She even gave her holiday home its own solar panel!

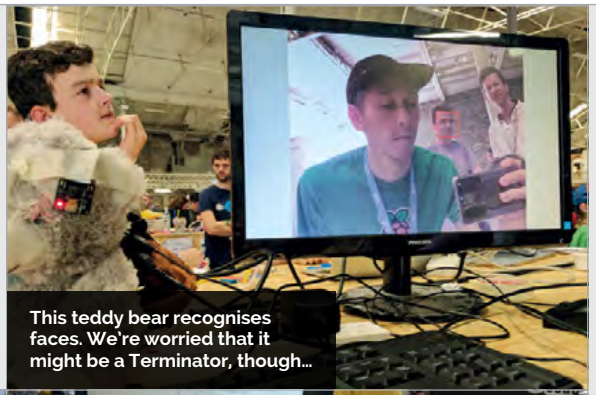
EVENT REPORT

What's being going on at Jams, Clubs, and Dojos around the world?

CODERDOJO COOLEST PROJECTS

Once a year in Dublin, a horde of coding ninjas gather to show off their finest making skills at CoderDojo's Coolest Projects event. This year, the event was held on Saturday 17 June at the Royal Dublin Society (RDS).

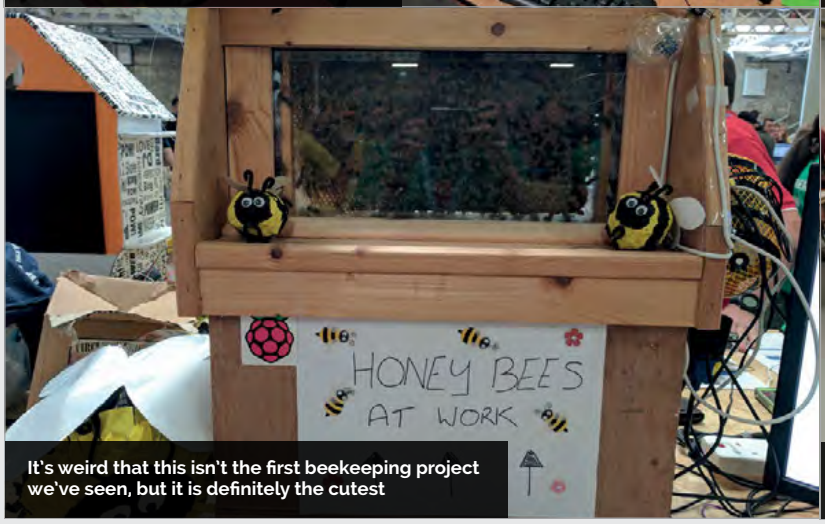
Raspberry Pi and CoderDojo have merged, so this year's event saw an increase in the Raspberry Pi Foundation attendance. Pi people scoured the show floor looking for the best and most awesome projects. Here's what they saw...



This teddy bear recognises faces. We're worried that it might be a Terminator, though...

The Northern Ireland Raspberry Jam team ran a conductive paint Minecraft Pi activity using the DOTS board

This LEGO robot makes the cut because, unlike most robots, it has a driver!



It's weird that this isn't the first beekeeping project we've seen, but it is definitely the cutest

This LEGO DUPLO house is fully automated like the house party scene in Home Alone

CODE CLUB STARS

Introducing a Code Club star from Brazil

WANT TO FIND OUT MORE ABOUT CODE CLUBS?
Head to codeclub.org.uk

Luciana Bezerra

Club: Code Club Casablanca, São Paulo

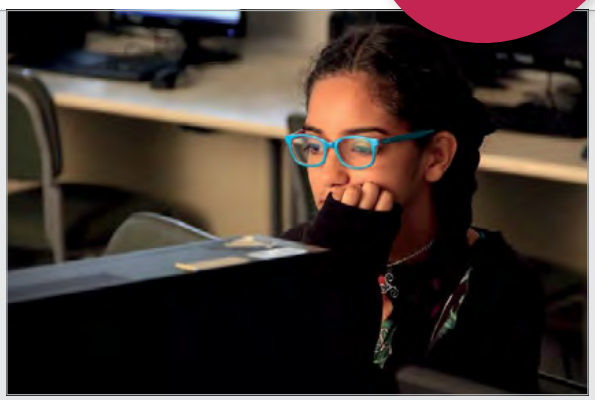
Web: magpi.cc/2rR9Ypz

What inspired you to volunteer for Code Club?
"I was inspired to share my knowledge of computers and programming. In Brazil, students in poor neighbourhoods usually don't have access to computer or game design courses. It is inspiring giving them access to these kinds of activities."

Tell us as a bit about your Code Club
"On the first day of class, I usually show one of the games that the students will make during the course. Most of them do not believe they will be able to program something like that. It is extremely rewarding to me to watch the students discovering that they are able to develop those games, and even to create other ones based on their own imagination. In some cases, the students can even discover an interest in pursuing IT as a job."

Why is Code Club important to you?
"Sharing my knowledge and knowing that it can change the future for some students is something priceless to me. Also, I have plenty of fun with it!"

What has been your best 'Code Club moment'?
"One day, the mother of one of the students went to Code Club and she was amazed to see her teenage son developing a complete game over the course of two hours. She raised the kid by herself and she doesn't have enough money to pay for computer/game courses for him. She was very grateful because a team of volunteers was there teaching and support her son."



EVENT HIGHLIGHTS

Here's what went on at Jams and other Raspberry Pi events around the world this month

FAMILY JAM

Building robodogs is all well and good, until they chase after the robo-postman! The Family Jam sounded great, though.

Science World
Some Pi-Makers of Vancouver with their @Raspberry_Pi projects. It's #RaspberryJam until 3pm at Science World!

SCIENCE WORLD

Canadian Raspberry Pi enthusiasts had a good time at Science World in Vancouver, showing off their truly excellent projects.

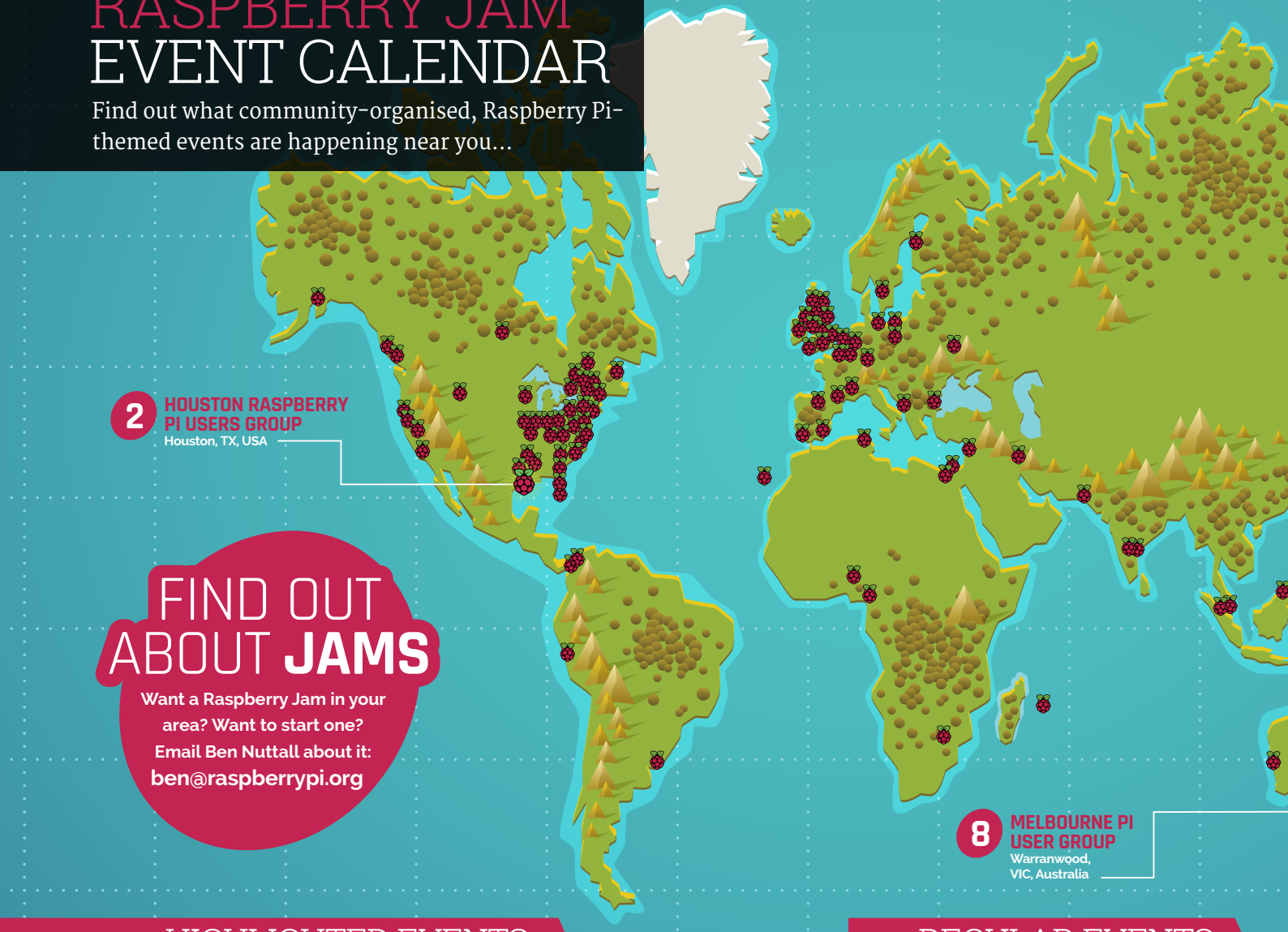
Giustina Mizzoni
Presents from @Raspberry_Pi team to brighten up post @CoderDojo @coolestprojects #MondayBlues #RaspberryJam Thanks @ben_nuttall

RASPBERRY JAM GUIDE

The Raspberry Jam starter kits are now out in the world, seen here with Giustina, Executive Director of the CoderDojo Foundation.

RASPBERRY JAM EVENT CALENDAR

Find out what community-organised, Raspberry Pi-themed events are happening near you...



FIND OUT ABOUT **JAMS**

Want a Raspberry Jam in your area? Want to start one? Email Ben Nuttall about it:
ben@raspberrypi.org

HIGHLIGHTED EVENTS

1 FUKUOKA RASPBERRY PI JAM

When: Monday 10 July
Where: Hakataeki-higashi 1-12-17, Fukuoka, Japan
magpi.cc/2rQbPL4
Hands-on demos and learning with the Pi in the first Fukuoka Jam, near Hakata station.

2 HOUSTON RASPBERRY PI USERS GROUP

When: Tuesday 11 July
Where: TXRX Labs, Houston, TX, USA
magpi.cc/2slyZMZ
An evening event where you can learn Pi basics and/or show off your Pi projects.

3 BECKFOOT THORNTON RASPBERRY JAM

When: Friday 14 July
Where: Beckfoot Thornton School, Thornton, UK
magpi.cc/2slbfbS
A fun evening of coding. If you don't have your own Pi, there will be equipment there for you to use.

4 RASPBERRY JAM MILTON KEYNES

When: Saturday 15 July
Where: The National Museum of Computing, Bletchley Park, UK
mkraspberryjam.org
Learn about Pi at the home of the world's first computer.

REGULAR EVENTS

5 BLACKPOOL RASPBERRY JAM

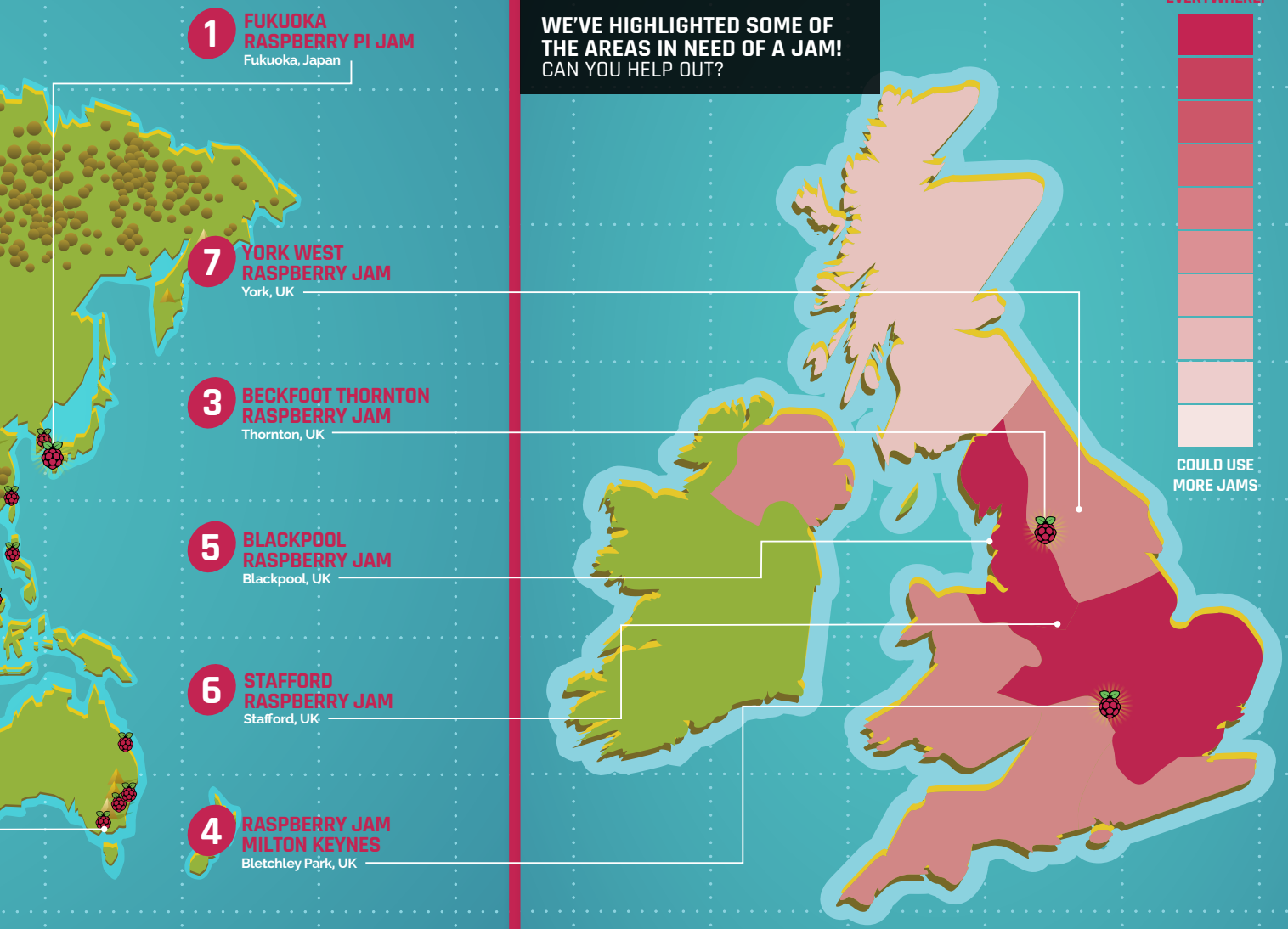
When: Saturday 8 July
Where: Palatine Library, Blackpool, UK
magpi.cc/2slhMDp
A place for parents and kids to learn more about computers, electronics, robotics, music, and art.

6 STAFFORD RASPBERRY JAM

When: Tuesday 11 July
Where: Stafford Library, Stafford, UK
magpi.cc/2sl6BKK
A big meetup where Pi enthusiasts get together to share ideas, help each other, and most of all have fun!

JAM HEAT MAP

WE'VE HIGHLIGHTED SOME OF THE AREAS IN NEED OF A JAM! CAN YOU HELP OUT?



7 YORK WEST RASPBERRY JAM

When: Monday 17 July
Where: Acomb Library Learning Centre, York, UK
magpi.cc/2sl6UVU

Everyone interested in Raspberry Pi computers should book a place to learn more about the Pi!

8 MELBOURNE PI USER GROUP

When: Tuesday 18 July
Where: Melbourne Rudolf Steiner School, Warranwood, VIC, Australia
magpi.cc/2mx2y7Y

The group's aim is to bring like-minded people together to talk about how they're using the Raspberry Pi.

MORE WAYS TO LEARN

RASPBERRY JAM STARTER KITS **NOW SHIPPING**

Every Raspberry Jam can apply for a Jam starter kit, which includes magazine back issues, printed worksheets, stickers, flyers, and more. It also includes access to our new Raspberry Jam branding, including logo and poster templates for you to use to promote your events. Kits have started to arrive with Jams and they're going down a storm! As soon as you've published your event, you can apply for your kit. You can also download the guidebook here: **magpi.cc/2q9DHfQ.**

YOUR LETTERS

Left You will hopefully be able to buy the AIY Projects voice kits soon. Sign up to our mailing list to find out when!

Getting AIY

I have been away for a while and missed out on buying issue 57 of *The MagPi* with the AIY Projects voice kit. The store where I usually buy it was all sold out and onto issue 58 of the magazine, but I'd still like to get it – is there any chance of a reprint of issue 57 with the kit attached?

At the very least, I'd be interested if you end up selling the kit on its own in the future. Are there any plans for that at all?

Stephen

Unfortunately we won't be reprinting issue 57, and even if we did, it wouldn't have the kit with it. However, the AIY Projects Voice HAT kit will hopefully be for sale at some point, although we don't know when that will be.

The best thing you can do is sign up for our mailing list. When Google confirms that it's going to be on sale, we can let you know. You can sign up here: **magpi.cc/Email-me**.

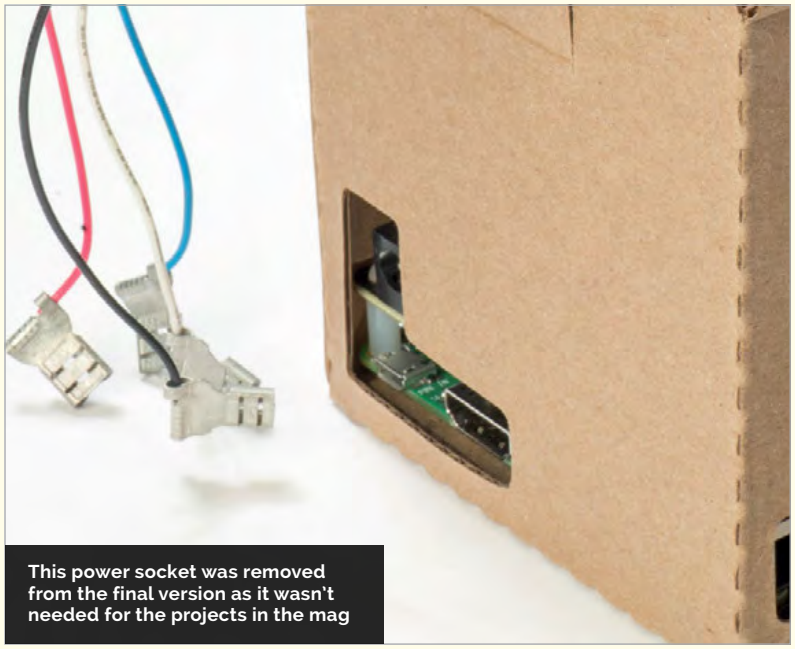
Live from Raspberry Pi

Could a Raspberry Pi be configured to be used with Facebook Live instead of a phone? It would make a great little project if we could create a camera that streams straight to Facebook Live, as phones aren't always the best way to do it. Is this doable, do you think?

Joe Linderman

Technically, yes, you can probably do this. At the very least, you can bring up Facebook in the browser and run live video from there. All you would need is a USB webcam, or a USB microphone and a Raspberry Pi Camera Module.

I'm guessing you're looking for a more portable project, though – like a video camera you can point at something, hit record, and stream the output to Facebook. The API for Facebook Live is out there, but you'd need to do some serious hacking to get it all working with the Pi. It wouldn't be easy or intuitive. Let us know if you succeed! In the meantime, you're probably better off using a spare phone.



This power socket was removed from the final version as it wasn't needed for the projects in the mag

AIY Projects power

I got the AIY Projects voice kit, but after an inspection I've noticed that the power port on the Voice HAT, which can be seen in images in the magazine, seems to be missing. Can I get a replacement at all, or will the Raspberry Pi power the Voice HAT properly?

Robin W

The Voice HATs with the power ports were the test HATs we used. The power ports weren't needed in the final version of the AIY Projects voice kit, as the Pi powers the Voice HAT, so they were taken off. You can easily solder one onto the board – it is useful if you need to supply power to accessories attached to the board that use more than the Pi can supply, such as servos and motors (see Page 62).

Look out for a future video on *The MagPi* YouTube channel on how to program servos and motors with your AIY kit: **magpi.cc/MagPiYT**.

FROM THE FORUM: X86EMULATION

The Raspberry Pi Forum is a hotbed of conversations and problem-solving for the community. Join in via **raspberrypi.org/forums**

I'm trying to find a free way to emulate x86 on my Pi to see what it can do game-wise. All I've got is ExaGear and a lot of people say nothing's gonna work - so if you're gonna tell me it's not gonna work, please don't tell me that as it's annoying. Anyways, if you know of any free methods that work, please tell me as I can't seem to find anything. Thanks!
Bunchie

As some people have pointed out in the forums, there's a reason why people were saying it wasn't going to work - but don't lose hope! You shouldn't expect to play Crysis on your Raspberry Pi, but with a bit more tweaking you should be able to get something working using ExaGear.

Otherwise, DOSBox is a good alternative (**dosbox.com**). You can use it on a Raspberry Pi to emulate Windows 3.1 and DOS, along with some other older OSes and x86 games. There's a great tutorial online here to show you how to use it: **magpi.cc/2rMmnea**.

WRITE TO US

Have you got something you'd like to say?
Get in touch via **magpi@raspberrypi.org** or on The MagPi section of the forum at: **raspberrypi.org/forums**

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- Custom enclosure

WDLABS

Sign up for news and updates at **wdlabs.io/mp59c**

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Competition closes on 26 July 2017. Prize is offered to participants world-wide aged 13 or over, except employees of the Raspberry Pi Foundation, the prize supplier, their families or friends. Winners will be notified by email no more than 30 days after the competition closes. By entering the competition, the winner consents to any publicity generated from the competition, in print and online. Participants agree to receive occasional newsletters from The MagPi magazine. We don't like spam: participants' details will remain strictly confidential and won't be shared with third parties. Prizes are non-negotiable and no cash alternative will be offered. This promotion is in no way sponsored, endorsed or administered by, or associated with, Instagram or Facebook.

MATT RICHARDSON

Matt Richardson is the Executive Director of the Raspberry Pi Foundation North America and author of *Getting Started with Raspberry Pi*. Contact him on Twitter @**MattRichardson**.

DEFINING DIGITAL MAKING

What exactly is digital making? **Matt Richardson** explains

The Raspberry Pi Foundation's mission is to put the power of digital making into the hands of people all over the world. But what does the term 'digital making' mean? What kinds of skills and activities are included? It's an important concept to understand in order to get a sense of what we set out to achieve – through our affordable computers, our outreach programs, and our support for educators and learners.

In Oliver Quinlan's Young Digital Makers, a report for NESTA which surveyed attitudes and opportunities for digital creativity across the United Kingdom, digital making is defined as 'learning about technology through making with it'. Therefore, it's not just about making something you want or need. At the core of digital making is the idea that an individual is learning when they create something with technology.

The link between making and learning is well known and its implementation in education is widespread worldwide. MIT Media Lab's Seymour Papert pioneered the learning theory of constructionism in the 1980s in his book, *Mindstorms*. Constructionism is the concept that people learn about a subject by creating something physical. In Papert's own words, "learning is most effective when part of an activity the learner experiences as constructing a meaningful product."

The first step

With technology like the Raspberry Pi becoming more accessible and affordable, it can become a material for digital making. Computers are typically thought of as tools for creating, but Papert had also envisioned computers being used as a material in projects. Products like the Raspberry Pi Zero are perfect as a material. The Zero is a powerful computer, and yet it's so affordable that it can be dedicated to a single project, no matter how simple that project is. Imagine creating a computer-based project just 15 years ago; it would have been very expensive!

The beauty of digital making is that when you practise it, not only are you learning through the process of making, as Papert theorised, but you're also gaining valuable STEM skills that are almost certain to come in handy in the job market. Developing a better understanding of code and electronics is a valuable skill in and of itself, and a skill that is likely to be increasingly in demand in the future.

While we tend to put a focus on learning among schoolchildren, I should also note that learning through digital making doesn't only happen with students in a classroom. Learning happens in libraries, museums, scout meetings, and makerspaces. It also happens in home garages and workshops. Learning through digital making doesn't only happen with young people, but people of all ages.

When I try to define digital making in my own words, I often tell people that it's a blend of a lot of different subject matters: computational thinking, coding, electronics, physical computing, design thinking, fabrication, project-based learning, and sharing. I know that's a lot of big stuff packed into one term, but digital making is a big thing and I suspect it is only getting bigger.

When we say that we want to put the power of digital making into the hands of people all over the world, we're taking on an ambitious task, and we have a lot of work ahead of us. Thankfully, digital making is also a fun and fulfilling activity. We only have to provide the affordable computers and free resources: the rest is up to you, digital makers!

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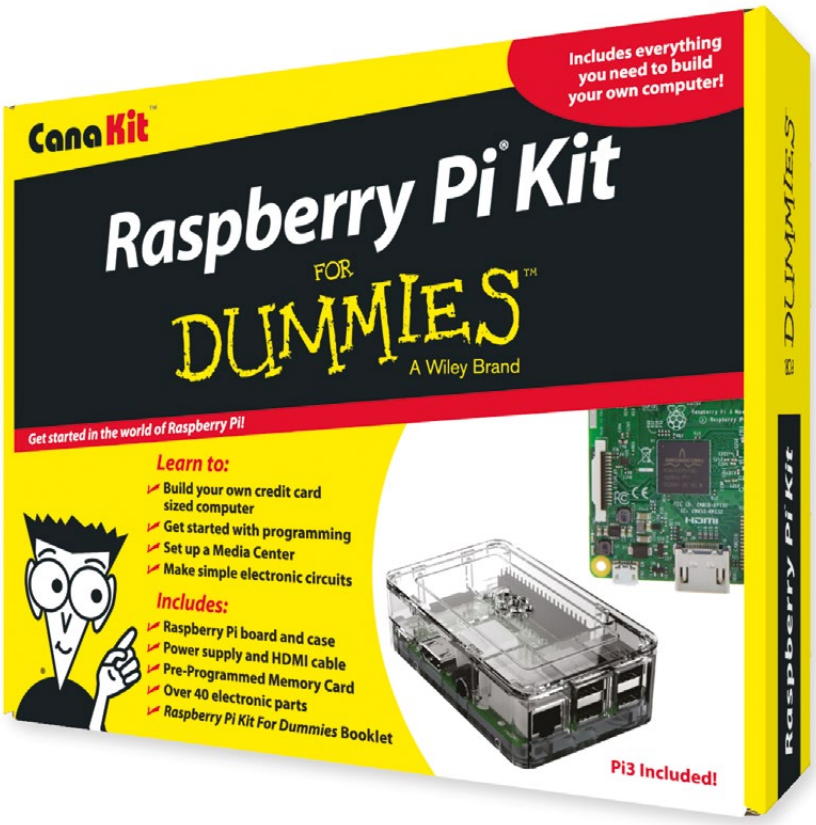

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